SECTION 2.0

EASTERN RANGE

RANGE SAFETY PROGRAM

2.1 INTRODUCTION

Section 2.0 describes the Safety Organization and the Range Safety Program for the Eastern Range and provides an overview of the features that comprise this program. The Range Safety Program has the authority and responsibility for both ground and flight activities such as test, checkout, assembly, servicing, and launch of launch vehicles and payloads to orbit insertion or earth impact. The following major topics are addressed:

- Safety Organization and Responsibilities
- Eastern Range Safety Policy
- The Eastern Range Safety Program

2.2 SAFETY ORGANIZATION AND RESPONSIBILITIES

A description of the range organization and responsibilities of the Chief of Safety is provided in Section 1. The following is a more detailed discussion of the functional safety responsibilities of the three primary safety sections (SEO, SEG, and SES) and their lower elements that are responsible to the Chief of Safety (see Figure 2-1).

2.2.1 Mission Flight Control and Analysis (SEO)

Mission Flight Control and Analysis is divided into three elements: Mission Flight Control (SEOO), ELV Operations Support and Analysis (SEOE), and Space Transportation System (STS) Operations Support and Analysis (SEOS).

SEOO is responsible for the following functions:

- Manages the launch vehicle flight safety program;
- Establishes requirements, directs, trains, qualifies, and provides Mission Flight Control Officers (MFCOs) for all major launch operations;
- Prepares documentation covering the policies, instrumentation, and equipment requirements for each major launch vehicle program;

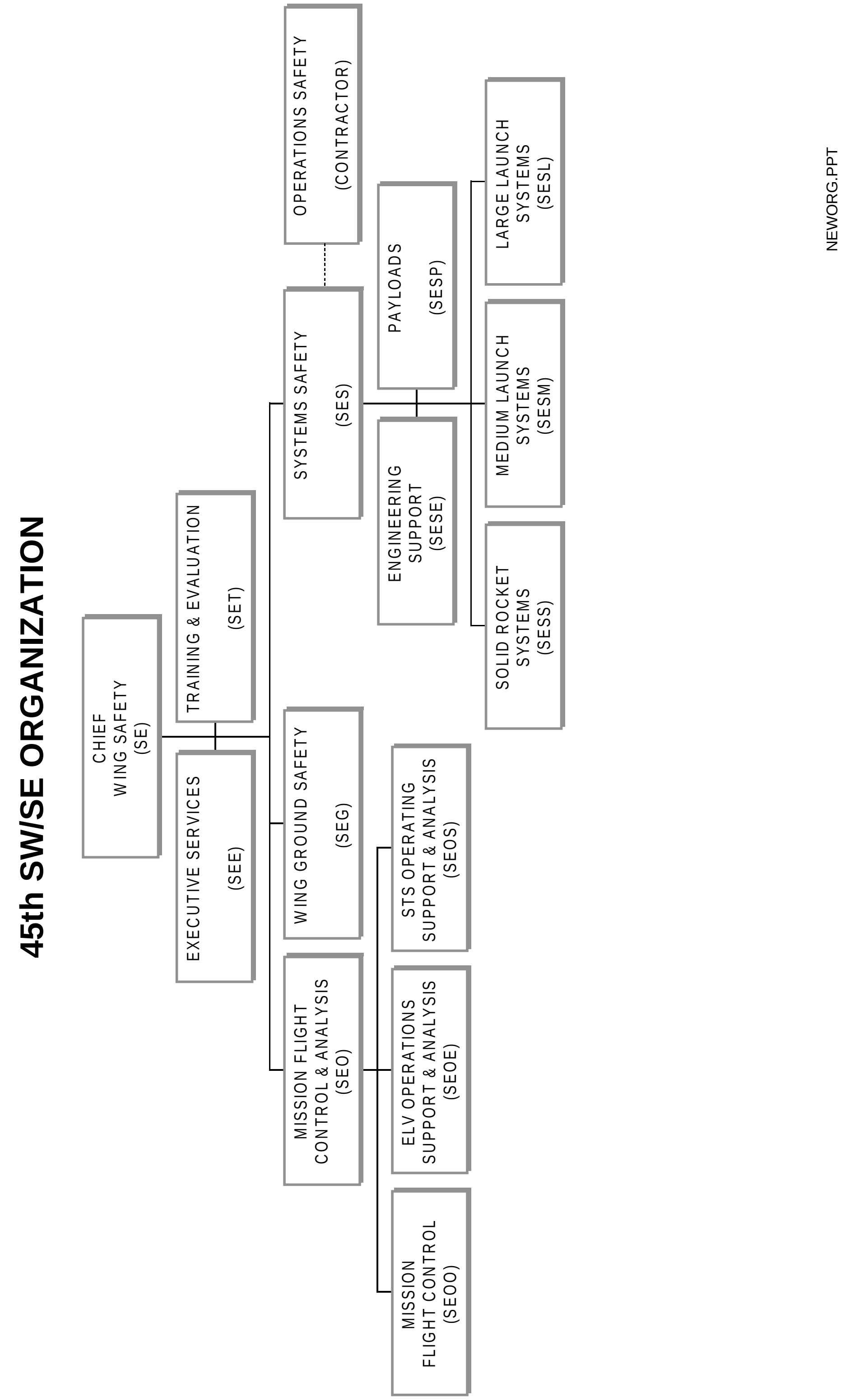


Figure 2 - 1 45th SW Safety Organization

- Monitors range instrumentation in support of launch operations;
- Participates in the design, development, test, and acceptance of flight safety equipment;
- Verifies that all safety conditions are met and provides a final Range Safety “clear to launch”;
- Terminates vehicle flight when people and/or property may be endangered;
- Advises the ER Commander of all real-time launch operations problems and decisions concerning in-flight safety.

SEOE and SEOS are responsible for the following functions (SEOE for Expendable Launch Vehicles and SEOS for Space Transportation Systems):

- Evaluates requests for flight plan approval and safety policy waivers;
- Determines need for flight termination systems on vehicles/payloads/upper-stages
- Analyzes launch vehicle trajectory, performance data, and instrumentation systems;
- Establishes impact limit lines and destruct criteria for each launch;
- Prepares input data to define safety displays for each launch vehicle;
- Computes ship/aircraft hit probabilities and approve intended support plans;
- Develops Range Safety policies, criteria, and operating procedures;
- Establishes requirements for real-time computations and displays;
- Develops mathematical models and programs for computing launch vehicle safety hazards;
- Establishes safe flight conditions for remotely piloted vehicles, aerostats, and “air-dropped” objects;
- Establishes launcher limits and operations restrictions for unguided rockets;
- Programs and operates computer terminals and peripheral equipment;
- Generates MFCO training simulations;
- Provides Chairman for the Interagency Nuclear Safety Review Panel - Launch Abort Sub-panel (INSRP - LASP);
- Implements the Air Force Occupational Safety and Health (AFOSH) program.

These elements are staffed with engineers, computer scientists, and mathematicians that provide technical support for launch pad and in-flight operations. These personnel quantify the risks and establish launch area restrictions and flight termination criteria to ensure that the risks are acceptable. They approve vehicle flight plans with coordination of the 45 SW Commander, and determine the need for Flight Termination Systems (FTS).

2.2.2 System Safety

System Safety (SES) is responsible for the following functions (SESS for small solid rocket systems, SESM for medium launch vehicle systems, and SESL for large launch vehicle systems):

- Develops and implements ground/industrial, explosive, nuclear, and system safety programs for the ER;
- Acts as the ER point of contact for all safety matters on policy other than flight and AFOSH Safety Programs;
- Ensures that public and launch site safety and resource protection are adequately provided by and for all programs using the range;
- Conducts specialized safety engineering analyses and studies;
- Provides safety engineering to assist in developing and enforcing engineering design requirements for hazardous launch vehicle flight, ground support, and facility systems;
- Reviews and approves pre-launch hazardous procedures;
- Monitors and controls hazardous operations;
- Develops processes and procedures to mitigate risks involved in pre-launch and launch operations for both the general public and launch site.
- Reviews/approves FTS design and test

NOTE: EWR 127-1 requires that the single commercial user, full-time government tenant organization, or USAF squadron/detachment commander, as the control authority, has the responsibility for launch complex safety and will exercise the function in accordance with the Range Safety Training and Certification requirements. The control authority has the option of delegating this responsibility to the Chief of Safety. In all cases, the Chief of Safety reviews and approves all hazardous operating procedures and any other procedures that Range Safety may review to ensure such operations do not pose or create a hazardous condition. If requested by the control authority, Range Safety ensures that all hazardous operations affecting launch complex safety are conducted using Range Safety-approved formal written procedures. Through Operations Safety, Range Safety ensures launch complex safety is provided in accordance with EWR 127-1 and approved Operations Safety Plans. If assuming responsibility, the control authority ensures that all hazardous operations affecting launch complex safety are conducted using formal written procedures approved by a space safety professional.

SESE is responsible for systems that are not directly related to a specific type of launch vehicle. For example, SESE develops flight termination system design criteria and requirements, reviews and approves qualification and acceptance tests, defines checkout requirements, and approves the FTS.

SESP is a special section responsible for safety concerns on classified payloads.

2.2.3 Ground Safety (SEG)

SEG is responsible for the following functions:

- Manages the ground, traffic, aircraft, and safety programs at Patrick Air Force Base (PAFB), Eastern Range downrange, and non-launch vehicle facilities at the Cape Canaveral Air Station (CCAS);
- Provides technical guidance in ground, flight, and safety matters for 45 SW, tenants, at these stations;
- Inspects government operations to ensure compliance with safety standards;
- Investigates, reports, and analyzes mishaps and develops corrective actions to prevent mishaps;
- Manages the hazard reporting and abatement programs;
- Conducts the Commander's Consolidated Safety and Health Council meetings;
- Trains unit safety representatives for all government units at ER stations;
- Develops and presents safety training programs as required;
- Manages the Hazardous Air Traffic Report and Bird/Aircraft Strike Hazard Reduction programs.

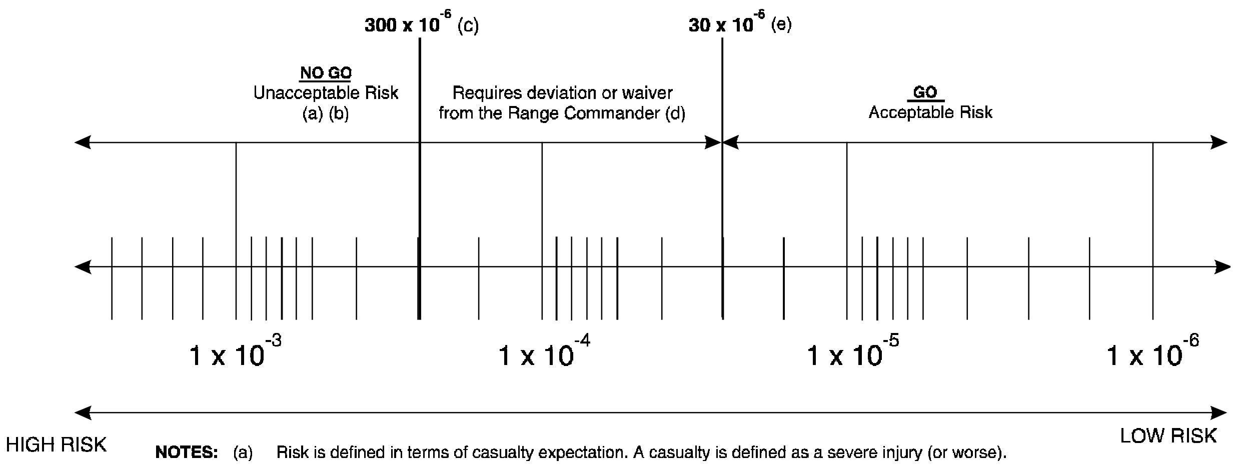
2.3 EASTERN RANGE SAFETY POLICY

2.3.1 Public Exposure

The ER acceptable risk guidance for public exposure to launch operations is shown in Figure 2-2. In addition, an impact probability (P_i) of 1×10^{-6} is usually the basis for aircraft approval and a ship-hit probability of 1×10^{-5} is usually acceptable for ships. These numbers are used as guides, not hard limits. The range user must endeavor to maintain the lowest risk level possible, consistent with mission requirements. Individual hazardous activities may exceed guidance based on national need or use of risk mitigation techniques.

The ER strives to ensure that the risk to the general public and foreign countries from Range operations does not exceed the risk to the general public from all natural causes and meets the guidance established in the legislative history of Public law 60. To that end, the Range will:

- Control all pre-launch and launch operations conducted on the range to ensure that the hazards associated with propellants, ordnance, radioactive materials, and other hazardous systems do not expose the general public to risks greater that those considered acceptable by public law and state regulations.
- Conduct and oversee launch and flight operations in a manner to ensure the risks to the general public, foreign countries, and the launch area do not exceed acceptable limits consistent with mission and national needs.
- Verify that all space vehicles and launch vehicles launched from or onto the ER have a positive, range approved method of controlling errant vehicle flight. This control must meet the objective of minimizing risk to the general public and foreign countries.



NOTES:
(a) Risk is defined in terms of casualty expectation. A casualty is defined as a severe injury (or worse).
(b) Unacceptable risk to the general public; does not meet the intent of PL60 or DODD 3200.11.
(c) The upper bound for essential launch area personnel is based on one casualty per 100 years with a launch rate of 33 per year.
(d) Cumulative risks at this level from multiple launches may drive the annual risk to be unacceptable.
(e) The upper bound for GO is based on an equivalent to an average of one casualty per 1000 years, with launches at the rate of 33 per year and assuming a population of 250,000 in the area of the launch facility.

("From a Safety Standpoint, they (missiles) will be no more dangerous than conventional airplanes flying overhead." Legislative History, 81st Congress, pg. 1235)

Figure 2 - 2: Risk Level Guidance for Public Exposure

2.3.2 Control Systems

Normally, control systems on launch vehicles using the range shall consist of an airborne Range Safety System meeting the requirements stated in the Range Safety Requirements, EWR127-1 (This document is available from the office of Range Safety). A thrust termination system may be considered as an alternative to an FTS, however, quantification of risks must be determined.

2.3.3 Clearance Zones

Safety clearance zones and procedures to protect the public on land, on the sea, and in the air are established and controlled for each launch and launch vehicle using the ER.

- No intact space vehicle, launch vehicle, payload, reentry vehicle, or jettisoned vehicle part is allowed to intentionally impact on land. Flight paths and trajectories are designed so that normal impact dispersion areas do not encompass land.
- Errant launch vehicles may be allowed to fly to obtain maximum data until they approach the point of presenting an unacceptable risk to the public, or the point where Range Safety is in danger of losing control the vehicle.
- Each launch system must have a hold-fire capability that prevents launch in the event of an unsafe range condition, loss of critical Range Safety systems, or violation of mandatory Range Safety criteria. Safety holds are initiated to prevent the start of an operation, or to stop an operation that is already underway, if it violates public safety, launch complex safety, or launch commit criteria. These holds may be called if safety criteria are violated or if adequate safety can not be ensured when personnel or resources are jeopardized. Safety holds may be initiated by Mission Flight Control Officers, Operations Safety Manager, Range Control Officers, range user, or any responsible supervisor in charge of an operation.

2.3.4 Safety Approvals

In order to operate, use, or launch from or into the ER, specific mandatory safety approvals must be obtained to show compliance with the requirements of the ER. In addition, commercial users must have an approved FAA license and meet the requirements of established regulations.

2.3.4.1 Wing Commander Approvals

The following safety approvals require the signature of the ER Commander:

- Tailored versions of EWR 127-1 affecting public safety;
- Range Safety mission flight rules, including termination (errant vehicle control) criteria for all launch vehicles;
- Range Safety launch commit criteria for all launch vehicles;
- The launch of launch vehicles whose risks to the public exceed 30 x 10^{-6};
- The launch of launch vehicles containing explosive warheads;
- The launch of nuclear payloads;
- Non-compliance affecting public safety.

2.3.4.2 Chief of Safety Approvals

The Chief of Safety or his designated representative may sign the following safety approvals:

- Flight Plan Approval. A flight plan approval must be obtained prior to the range commitment to support a final launch readiness review. Plans, required data, and formats, together with submission lead times, are described in Chapter 2, EWR 127-1. (See Table 2-1)

Table 2 - 1: Lead Times for Required Data

Type of Launch Vehicle	Type Mission/Condition	Lead Time Before Launch Calendar Days
New System/Program	First launch or Test	
Preliminary Flight Plan Approval		One Year
Final Flight Plan Approval		4 months-2 months
Ballistic Launch Vehicle (1)	Single Flight Azimuth, Multiple Trajectory or Flight Azimuth	60 Days
Space Vehicle (1)	Single Flight Azimuth or Variable Flight Azimuth	60 Days
Cruise Launch Vehicle/Remotely Piloted Vehicle	Ground or Air Launched	60 Days
Small Unguided Rocket	Without Destruct System	60 Days
Aerostat/Balloon	Tethered or Un-tethered	60 Days
Projectile, Torpedo, Airdropped Body or Device	Miscellaneous	60 Days
Support Aircraft/Ships	Intended Support Plans	20 Days

Note: (1) Programs with Flight Plan Approval

- Range Safety System Approval. The range user in accordance with Section 4.4 and Appendix 4A of EWR 127-1 shall submit a Range Safety System Report (RSSR).
- Missile System Pre-launch Safety Package (MSPSP) Approval. The range user in accordance with Section 3.4 and Appendix 3A of EWR 127-1 shall submit a MSPSP.
- Launch Approval. Wing Safety's GO at the Launch readiness Review (LRR) normally constitutes approval to launch, and is contingent on the Range User having obtained the required approvals identified in Chapter 1 of the EWR 127-1. Lack of approval may result in the launch being withdrawn from the Range schedule.
- The following safety approvals shall be authorized by the Chief of safety or a designated representative:

    Non-compliance not affecting public safety

    System Safety Program Plan

    Launch Complex Safety Training and Certification Plan

    Preliminary and Final Flight Data Packages

    Aircraft and Ship Intended Support Plans

    Directed Energy Plans

    Hazardous and Safety Critical Procedures

    Facilities Safety Data Package

    Final Range Safety Approval for launch

    Range Safety Instrumentation, tracking, data, & display requirements for all vehicles

2.4 THE EASTERN RANGE SAFETY PROGRAM

The objective of the Range Safety Program is to ensure that the general public, launch area personnel, foreign land masses, and launch area resources are provided an acceptable level of safety and that all aspects of pre-launch and launch operations adhere to public laws and national needs. The mutual goal of the Ranges and Range Users shall be to launch vehicles and payloads safely and effectively with commitment to public safety

2.4.1 Launch Vehicle System Ground Safety

All flight hardware, ground support equipment, facilities, and operations associated with activities on the ER that have the potential to present a hazard to the general public must be approved by Range Safety. This approval is given when Range Safety has received, reviewed, and approved the data contained in the Missile System Prelaunch Safety Package.

2.4.1.1 Missile System Prelaunch Safety Package (MSPSP)

The MSPSP is the data package that describes in detail all hazardous and safety critical systems/subsystems and their interfaces in vehicles, payloads, ground support equipment, facilities, and launch pads. In addition, the MSPSP provides verification of compliance with EWR 127-1 and Appendix 3A. The MSPSP must be approved by Range Safety prior to the arrival of any launch vehicle/payload element, activation of a hazardous processing facility, or commencement of any hazardous operation on the ER. Supporting documentation is submitted as deemed necessary by Range Safety. The following is typical of the information presented in the MSPSP.

2.4.1.1.1 Introduction

This section contains brief statements of the purpose of the MSPSP, the type of launch vehicle, payload and mission, a brief description of changes from previous vehicles/payloads, and other general information thought to be useful, such as sketches of the vehicle, payload, or facility.

2.4.1.1.2 General Description of the Launch Vehicle, Payload, and Facilities

This section provides an overview of the system as a prologue to the subsystem descriptions. It also includes information as to physical dimensions and weight, nomenclature of major subsystems, type of motors and propellants to be used, and sketches/photographs of the vehicle/payload/facility. A synopsis is provided for each hazardous subsystem.

2.4.1.1.3 Subsystem Description

This section describes each of the hazardous subsystems by giving an overview of each system, and then describing each item in terms of nomenclature, function, location (using sketches), operations (using schematics and /or flow charts), design parameters, testing, operating parameters, and hazard analyses. Supporting data is included or summarized and referenced, as appropriate, with availability upon request. Specific data requirements for hazardous subsystems are contained in EWR 127-1; however, additional data may be required, as necessary, to substantiate the safety of the system. Tables, matrices, and sketches are required to provide component data. The MSPSP must have a subsection for each of the following systems, subsystems and components:

- Structures/Mechanisms
- Propellant and Propulsion Subsystems

- Electrical and Electronic Subsystems
- Pressure Subsystems
- Ordnance Subsystems
- Non-Ionizing Radiation Subsystems
- Ionizing Radiation Subsystems
- Acoustical Subsystems
- Hazardous Materials
- Computing Data Systems
- Ground Support Equipment (GSE) (including government-furnished and Range Contractor-furnished equipment). The GSE section must be organized by hazardous subsystem and shall account for all GSE. A section on personal protective equipment is also provided.
- Subsequent sections are added, if required, to provide any other data pertinent to the safety of prelaunch and launch operations. Range Safety will request additional information, as required, for a thorough assessment of the system.

2.4.1.1.4 Ground Operations

The following information can be submitted separately as part of a Launch Base Test Plan or Ground Operations Plan if so stated in the MSPSP. Separate submittals must be provided with each MSPSP and must, as a minimum, identify the ground processing flow, including all hazardous operations.

- All procedures (hazardous and non-hazardous) that are to be used at the range must be listed by title and numerical designation with an indication as to which have been designated as hazardous or related to flight termination system operations. Procedure descriptions must include separate listing of tasks so those hazardous tasks within each procedure can be identified.
- A task summary of each procedure must be provided. This must include: each separate task, responsible agency, objective, initial/final configuration, equipment/support required, description, hazards and precautions, and figures, if required.
- A flow chart must be included that indicates expected time sequence and location of each individual procedure/task. The purpose of this is to evaluate simultaneous operations, hazards, and controls, and to ensure changes in the hazardous configuration of the facilities and hardware are identified. This flow chart must include an identifier for each procedure. The identifier contains procedure number, hazardous or non-hazardous designation, and task summary number.
- Provisions for emergency and abort/back-out situations must be identified.

2.4.1.1.5 Off-site Processing

Range users must provide a detailed description of off-site configuration (both build-up and transport) for booster/payload elements that will be transported to the Cape Canaveral Air Station. A description must be provided of the tests performed on safety critical systems, such as rotation of Safe & Arm devices, no voltage checks of ordnance, pressure checks of pressure/propellant vessels, RF radiation measurements, and preliminary FTS checks. In addition, five working days prior to hardware arrival at CCAS, the user must provide the following to Range Safety for approval:

- A final transportation plan;
- A statement certifying that the configuration of hazardous systems has not changed from the approved configuration described in the MSPSP;
- A statement certifying that the flight termination system (if installed) has not been modified, moved, or readjusted without being witnessed and approved by Range Safety or their representative.

2.4.1.1.6 Compliance Checklist

A checklist of all design, test, and data submittal requirements in EWR 127-1 must be provided in the MSPSP. The checklist must indicate the following for each requirement:

1. criteria/requirement
2. system
3. compliance
4. non compliance
5. not applicable
6. resolution
7. reference

2.4.1.1.7 Changes to the MSPSP

Changes to the MSPSP should reflect any system or component changes. All changes must be reviewed and approved by Range Safety prior to arrival of modified/new hardware.

2.4.1.2 System Modification

Once hazardous systems have been approved, their configuration, components, and interfaces with other systems are not modified without Range Safety concurrence.

2.4.2 Flight Safety

This section covers the requirements that the range user must meet before conducting a mission or flight operation on the Eastern Range. These requirements are for trajectory data and system flight characteristics for ballistic launch vehicles and space vehicles. It also covers the data requirements and procedures for obtaining approval for mission flight plans. Using the data submitted by the range user, Range Safety analyzes each mission from a flight safety standpoint and prepares safety criteria for the safe conduct of the mission.

2.4.2.1 Flight Plan Approval (FPA)

Approval of a proposed flight plan or mission by the Chief of the Safety Office, or a designated representative (SEO), is a necessary prerequisite for flight operations and tests, and indicates the hazards associated with the launch are at an acceptable level. The range user should initiate flight plan approval action at the earliest practical date to establish that the proposed mission or trajectory is acceptable from a safety standpoint. Ideally, flight plan approval for each mission should be requested during the initial planning or conceptual phase. For new programs, a request should accompany the Program Introduction or, in any event, be submitted immediately after the range has replied to the Program Introduction with a Statement of Capability or at least 2 years prior to launch. For launch vehicle programs already active on the range, discussions and correspondence concerning flight plan approval should begin at least one year prior to launch.

The flight plan approval request addresses the applicable requirements of EWR 127-1 to the greatest extent possible. In many cases, the information provided suffices for evaluation of the flight plan. In other cases, where the proposed plan exceeds normally accepted limits, such as flying a trajectory too steep to allow protection of the launch area, flying too close to or spending too much-dwell time over land, or impacting jettisoned vehicle parts too close to land, additional data will be required. In any event, Range Safety will respond in writing to the flight plan approval request by issuing a letter of approval or disapproval, by requesting that a change in the proposed plan be made or investigated, or by delineating the additional data required before a decision can be made. Trajectory data are examined after flight plan approval; in order to do risk analyses (see paragraph. 2.4.2.6).

The approval letter will specify the conditions of approval pertaining to such things as flight azimuth limits, trajectory shaping, wind restrictions, locations of impact areas, times of discrete events, and number of vehicles or missions for which the approval applies. The approval will be final as long as the mission remains within the stated conditions.

2.4.2.2 Flight Plan Approval Procedures

The range user should submit a FPA request as early in the planning phase of the program as possible. The information that should be submitted with the request is specified in EWR 127-1. If sufficient data are not available to meet the requirements, the range user should meet with SEO to discuss the program and to provide all available information. SEO will review the available data and advise the range user of additional data or hazard analyses that are required. At this time in the program development, the design of the vehicle systems may not be fixed. SEO will make the range user aware of the flight safety requirements so that the design of the safety systems and other systems will meet the requirements of EWR 127-1.

Significant in the approval procedure is that the range user provide all data needed by SEO early enough that the processing of the FPA request can be completed prior to the time that the design of all systems that affect safety are finalized. If the SEO processing takes two months, the range user's data must be submitted two months before systems are finalized or two months before the range user requires FPA, whichever is earlier.

2.4.2.3 Flight Plan Approval Letter

The range user is advised, as soon as possible, of the acceptability of the vehicle safety systems and the flight plan. This information can be communicated in briefings, telephone conferences, and letters to allow the range user to expedite making modifications or submitting waiver requests to conform to the safety requirements. Formally, a FPA letter is prepared by SEO that sets forth the safety position of the range user's request for FPA, which is signed by the Chief of Safety or his designated representative. This letter contains the following information, as applicable:

- The requirement, or lack thereof, for an FTS on stages or payloads to control the flight of a malfunctioning vehicle.
- The adequacy of a command control system throughout powered flight in accordance with EWR 127-1;
- FPA is based on final trajectory data.
- An assessment of over-flight casualty expectancies associated with the planned launch and a comparison of these hazards to previously acceptable casualty expectancies for similar flights;
- Any restraints on the launch, such as flight azimuth or launch area wind conditions;
- Description of waivers that have been requested by the range user and their resolution;
- A statement that final trajectory data for the launch must be provided in accordance with EWR 127-1 even though the FPA is granted;
- Any other information that the SEO analyst believes is qualifying to the FPA.

2.4.2.4 Flight Safety Restrictions

No launch vehicle, space vehicle, payload, reentry vehicle, or jettisoned component will be intentionally impacted on land. Proposed flights must be planned and trajectories shaped so that normal impact dispersion areas for such items do not encompass land. A sufficient safety margin should be used to avoid overly restrictive flight termination lines. If a stage contains multiple-burn engines, the impact dispersion area corresponding to any planned cutoff before orbital insertion must be entirely over water. Critical events (such as arming of engine cutoff circuits and sending of backup engine cutoff commands) must be sequenced to occur when the impact dispersion areas are entirely over water.

2.4.2.5 Flight Termination Systems

All vehicles launched on the range must be equipped with a flight termination system that meets the requirements defined in EWR 127-1. This system must be redundant and capable of termination of thrust on any or all stages at any time in flight, up to the point of final impact or orbital insertion. The overall system reliability goal of the flight termination system is a minimum of 0.999 at 95% confidence. Using the design approach and testing requirements described in EWR 127-1 satisfies this reliability goal. Small rockets whose impacts can be adequately controlled by pre-launch restrictions are excluded from this requirement.

2.4.2.6 Flight Safety Analysis

Before flight plan approval is granted, the range user must submit a Flight Data Package, which provides detailed trajectory and vehicle performance data, in specified formats, in accordance with lead times established in Table 2, and required by EWR 127-1. If the deadlines for trajectory and vehicle performance data are not met, the Flight Analysis Section may be unable to prepare the necessary safety criteria in time to support a proposed flight test or operation. In this event, the test or operation will not be conducted until adequate safety preparations can be made.

SEO uses the data submitted in the Flight Data Package to assess flight plan approval and prepare safety criteria designed to protect critical areas from the potential hazards of an errant vehicle. Critical areas are generally populated, but can also include critical facilities and launch vehicles. Unpopulated land masses, boats, ships, and aircraft routes can also be considered critical depending on the launch vehicle and its trajectory. Sets of criteria are developed for each launch for presentation on the MFCO console. The Range Safety displays show real-time plots of Instantaneous Impact Point (IIP) and Vertical Plane (VP) present position data plotted over background displays. The background contains nominal and dispersed trajectories that define the limits of a normally performing vehicle, and IIP and VP destruct lines. A normally performing vehicle is one that does not exceed three-sigma performance limits. Any deviation outside these limits indicates that the vehicle is not performing within normal limits, though not necessarily posing a threat to populated areas. The flight termination criteria ensure that MFCO destruct action will not be taken for a vehicle performing normally within three-sigma limits.

2.4.2.6.1 Impact Limit Lines

Impact Limit Lines (ILL) are established to define the launch and downrange areas to be protected. Significant debris pieces that could cause personal injury or property damage from malfunctioning launch vehicles must be contained inside the ILLs. The northern ILL, which is extended to the north and east of CCAS, is designed to protect commercial air lanes north of the CCAS, depending on the vehicle launch location and flight azimuth. Air traffic is closed in the critical air lanes if they cannot be protected. Regardless of air lane protection, the northern ILL is extended to protect the coast of Florida and the Azores, Canary Islands, Cape Verde, and the West Coast of Africa. The southern ILL for all launches is extended south and east of CCAS and protect the coast of Florida until 27 degrees latitude and then continued in straight line segments off the coastline of the Bahamas and on to the Lesser Antilles and to South America. The southern ILL can be extended southeast from the coast of South America to protect the area downrange and South America (see paragraph. 2.4.2.6.7). An eastern ILL, which runs north south and joins the northern ILL with the southern ILL, protects all land areas of Africa except downrange of the African gate. (See Figures 2-3 and 2-4.)

2.4.2.6.2 Destruct Lines

Flight termination, or destruct lines, are designed to protect areas behind ILLs from vehicle malfunctions that result in the violation of a particular destruct line. The destruct lines are presented as solid lines on the Range Safety display IIP maps. The reason these lines are offset from, and inside, the ILLs is because the vacuum IIP presentation does not include drag, wind, and explosion velocities. Activation of the flight termination system by the MFCO, upon violation of the destruct lines, prevents significant debris from exceeding the ILL. The separation distance between destruct lines and ILLs is a function of system delays, data uncertainties, MFCO reaction time, winds, explosion velocities, and performance characteristics of the vehicle. (See Figure 2-4.)

2.4.2.6.3 Launch Area Safety Criteria

Present position and impact prediction displays are used for protection of the critical launch areas. Multiple sets of launch area criteria are prepared for the vertical plane present position, chevron lines, and launch area IIP displays based on two or three different wind conditions. These wind conditions are statistical wind profiles and are characterized in terms of percentiles for monthly, seasonal, or annual periods. The profiles show wind direction and velocity vs. altitude. The sets of criteria prepared reflect the least to the most restrictive wind profile that does

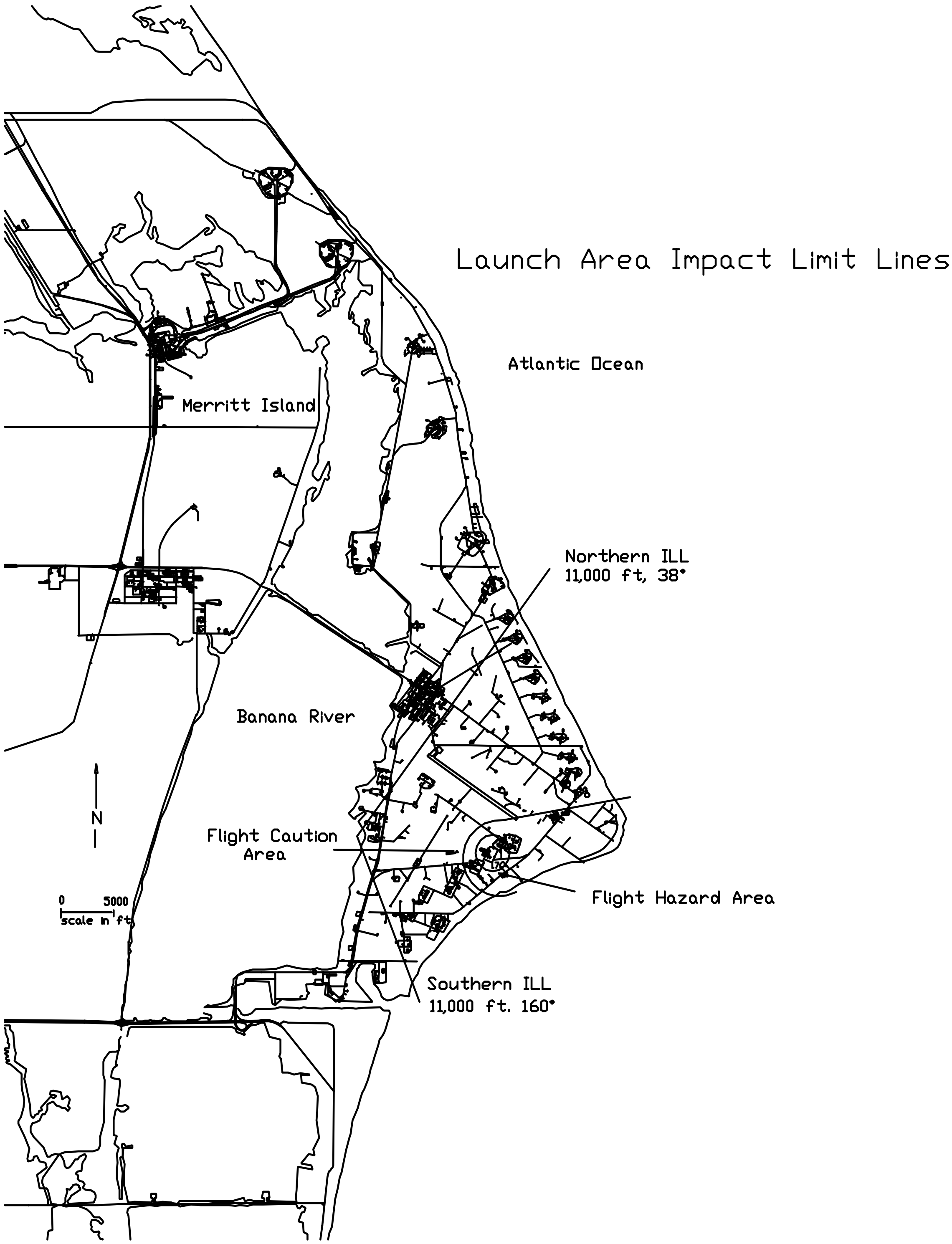


Figure 2 - 3: Example of Launch Area ILL, *FHA and FCA*

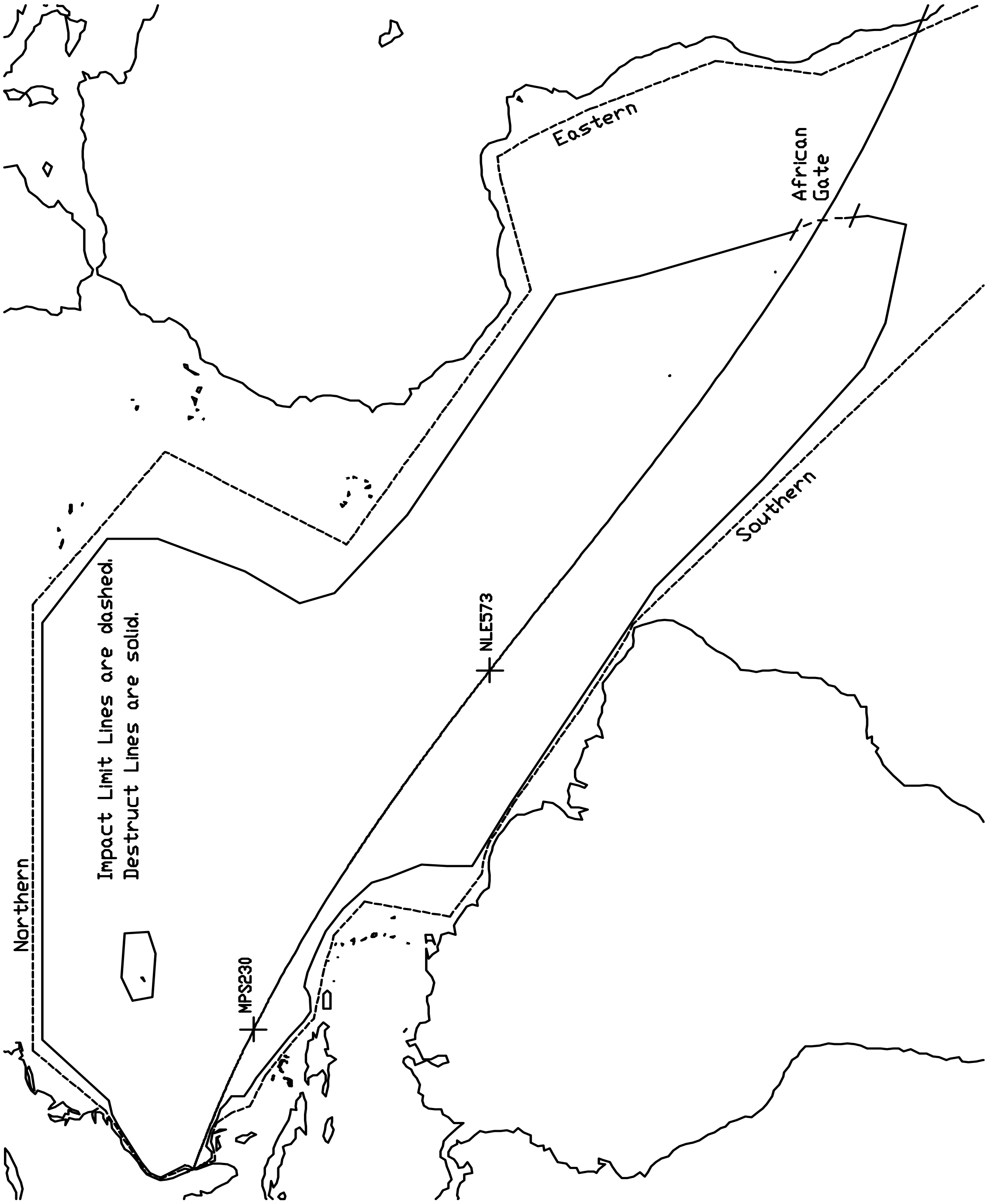


Figure 2 - 4: Impact Limit Lines and Destruct Line Examples

not endanger the flight of a vehicle performing within normal limits. Of these sets, the one that best reflects the winds forecast for the time of launch will be determined by SEO during the minus count using the Range Safety Wind Check computer program.

2.4.2.6.4 Instantaneous Impact Point

Real-time computer programs receive tracking system and vehicle telemetry data from the Eastern Range, NASA, and other instrumentation systems. The real-time computer system computes and outputs the IIP of the vehicle to the Range Safety display system. The nominal and three-sigma reference trajectories are displayed along with applicable destruct lines/criteria as background references. The MFCO monitors the real-time IIP throughout powered flight. Since the MFCO must determine that the IIP of the vehicle is within safety constraints as it progresses downrange, the IIP is displayed on several progressive maps (up to 12). Map centers and scales are designed to ensure adequate resolution and overlap, and to avoid loss of coverage. The maps gradually decrease in scale as the vehicle progresses downrange, with computer logic determining when to switch maps.

2.4.2.6.5 Vertical Plane Present Position

Projections of the present position trajectory are displayed on two vertical planes (VP), referred to as XZ and YZ, for comparison with the nominal trajectory and launch area safety criteria. The XZ plane that protects the Northern ILL is the right half of the display and the YZ plane that protects the Southern ILL is the left half of the display. The safety criteria or destruct lines shown on these displays are designed to protect the critical areas in the launch area. The nominal and dispersed trajectories, for both the XZ and YZ planes, are shown for MFCO reference. The dispersed trajectories consider performance variations and extreme winds, and define the normal vehicle operating limits. Launch area safety criteria, or destruct lines presented in these vertical planes, take on the form of a family of curved lines. Safety criteria are violated when the track of the vehicle becomes parallel to a destruct line (see Figure 2-5).

Vertical plane destruct lines are generated by a combination of computer programs. Input data consist of nominal trajectory position and velocity components, maximum turning rates of the vehicle, vehicle debris class breakup data, and explosion velocities imparted to vehicle debris as a result of flight termination action. Also input are the range from the pad to the ILL and selected wind profiles. The total time delay used in the vertical plane destruct lines is usually 4.0 seconds (this includes the MFCO reaction and decision time of 2.5 seconds).

The time that a nominally performing vehicle can no longer rise vertically (straight-up time) without having the capability to endanger the impact limit line is shown in the center of the vertical plane display. Typical straight-up times are Atlas-70 seconds and Delta-30 seconds.

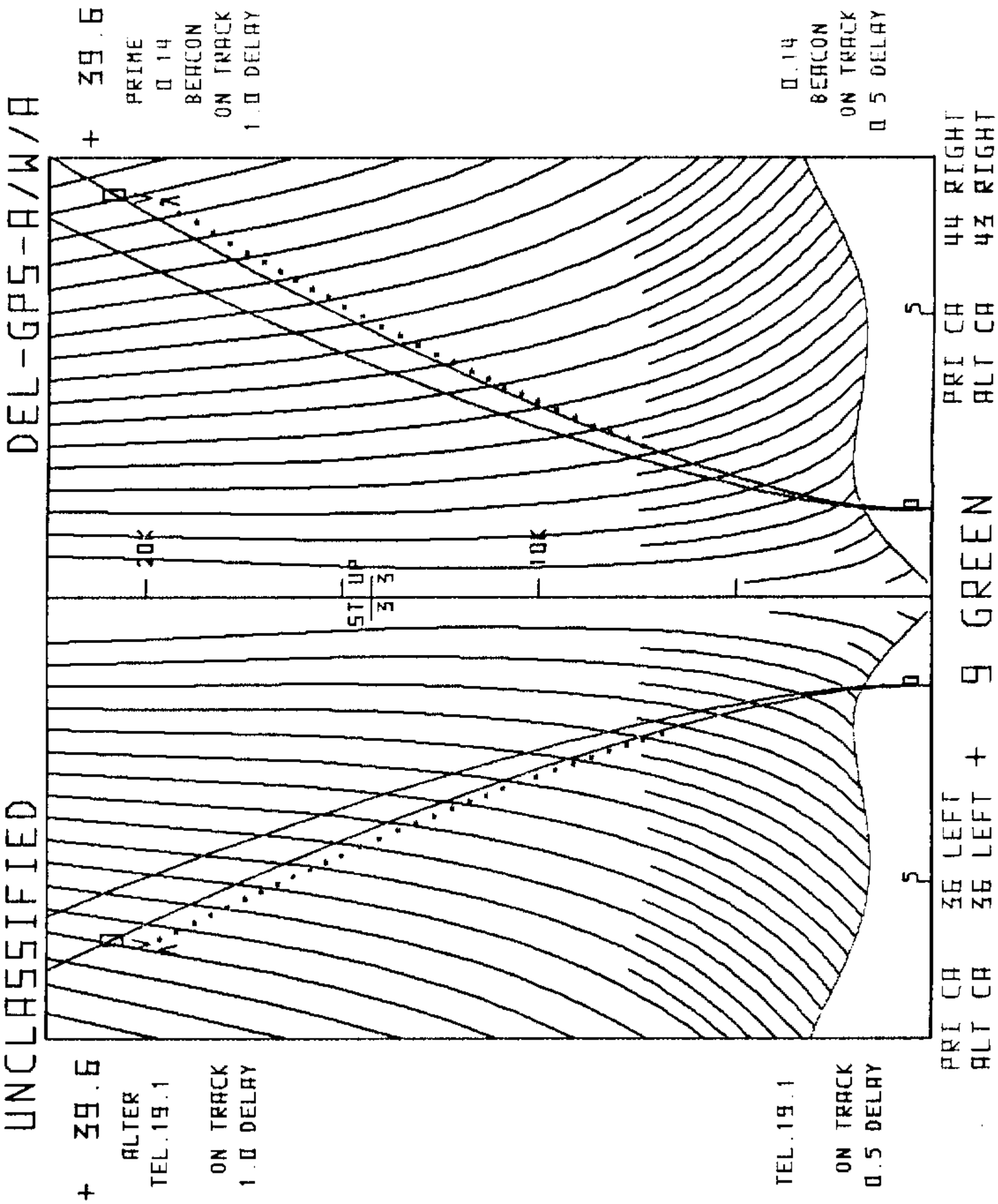


Figure 2 - 5: Vertical Plane Display Example

2.4.2.6.6 Chevron Lines

Moving (multiple) destruct lines are developed to protect the launch area ILLs from a vehicle pitching up with the IIP moving up-range. These moving destruct lines are presented as a function of vehicle velocity. The shape of these lines takes on the appearance of chevrons; hence they are named chevron lines (see Figure 2-6). In real-time, the chevron lines are presented at ten points per second as a function of velocity on the Range Safety display. As the velocity changes, the chevron line is updated and appears to be a continuously moving line. The criterion for acceptable vehicle performance is that the vacuum impact point of the vehicle is on or downrange of the applicable chevron line. An impact point uprange of the line violates the chevron line destruct criteria. The chevron line disappears from the display when the vehicle velocity exceeds the velocity associated with the last chevron line. Input data are similar to data required for computing vertical plane destruct lines.

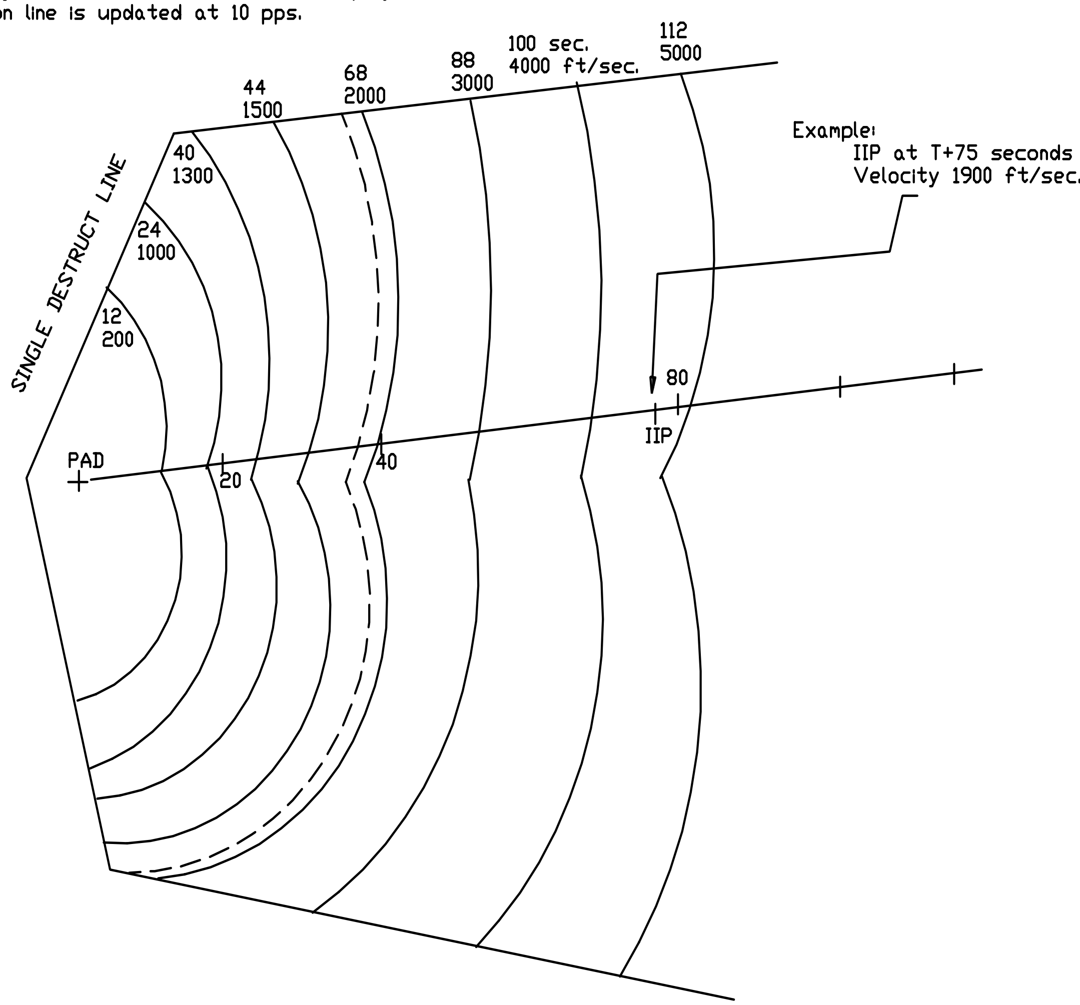
2.4.2.6.7 Downrange Safety Criteria

Downrange background displays are prepared for the protection of downrange critical areas. These displays consist of flight termination criteria in the form of single destruct lines and informational plots of the nominal and three-sigma right and left vacuum impact point loci. The three-sigma impact point loci define the normal limits of lateral impact point dispersions considering winds and performance variations. The real-time IIP is calculated at ten points per second and sent to the Range Safety displays. Staging times and other critical in-flight events are also shown as background data for the MFCO.

Single destruct lines on the IIP displays protect downrange critical areas from the launch area to a point downrange where the vehicle passes through the African European Gate. Although available for the early phase of flight, they are seldom used then because vertical plane and chevron safety criteria are specifically designed to protect the launch area and are presented until the vacuum impact point is about 100 miles downrange.

The vacuum impact point track associated with orbital missions from CCAS passes over landmasses such as Europe, Asia, or Africa prior to orbital injection, depending on launch azimuth (see Figure 2-7). Therefore, the single destruct lines protecting these land areas must be opened to allow vehicles performing within normal limits to over-fly land. Openings in destruct lines may also be needed earlier in flight for missions that fly over, or too close to, land to allow the flight of a vehicle performing within normal limits. These openings are referred to as “Gates”. The size of a gate is dependent upon the space booster and +/- three-sigma trajectories (see Figure 2-8). The use of gates is covered in the mission rules for each applicable operation.

Time, velocity and geodetic coordinates of solid lines input to Cyber by SEY.
Chevron line is interpolated from input lines as a function of velocity and appears to move.
The dashed line, determined by linear interpolation between the 1500 and 2000 ft/sec. chevron lines, is the only chevron line (1900 ft/sec.) displayed at this instant of time.
Chevron line is updated at 10 pps.



Chevron Lines

Chevron number is determined by subtraction from the time it would take for the chevron line to reach the IIP by the time that a nominal vehicle would achieve the present velocity. For this example, the first time is determined by linear interpolation between the 100 and 112 chevron lines. Assume 105 seconds. The time to be subtracted is that time that a nominal vehicle would achieve a velocity of 1900 ft/sec. (from table look-up). Assume 65 seconds, 105 minus 65 would give a chevron number of 40 for this example.

Figure 2 - 6: Chevron Lines Example

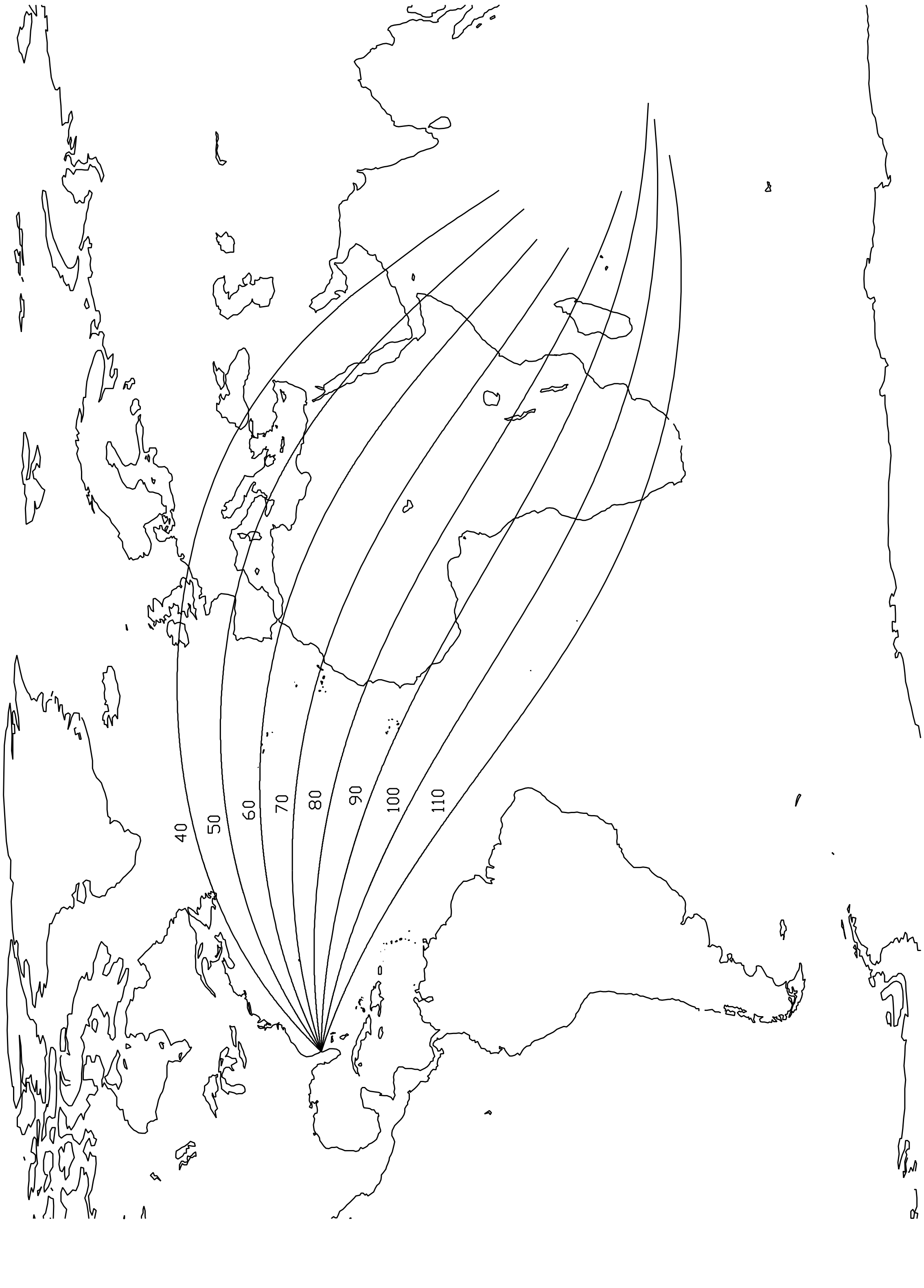


Figure 2 - 7: Typical Ground Traces for CCAS Launches

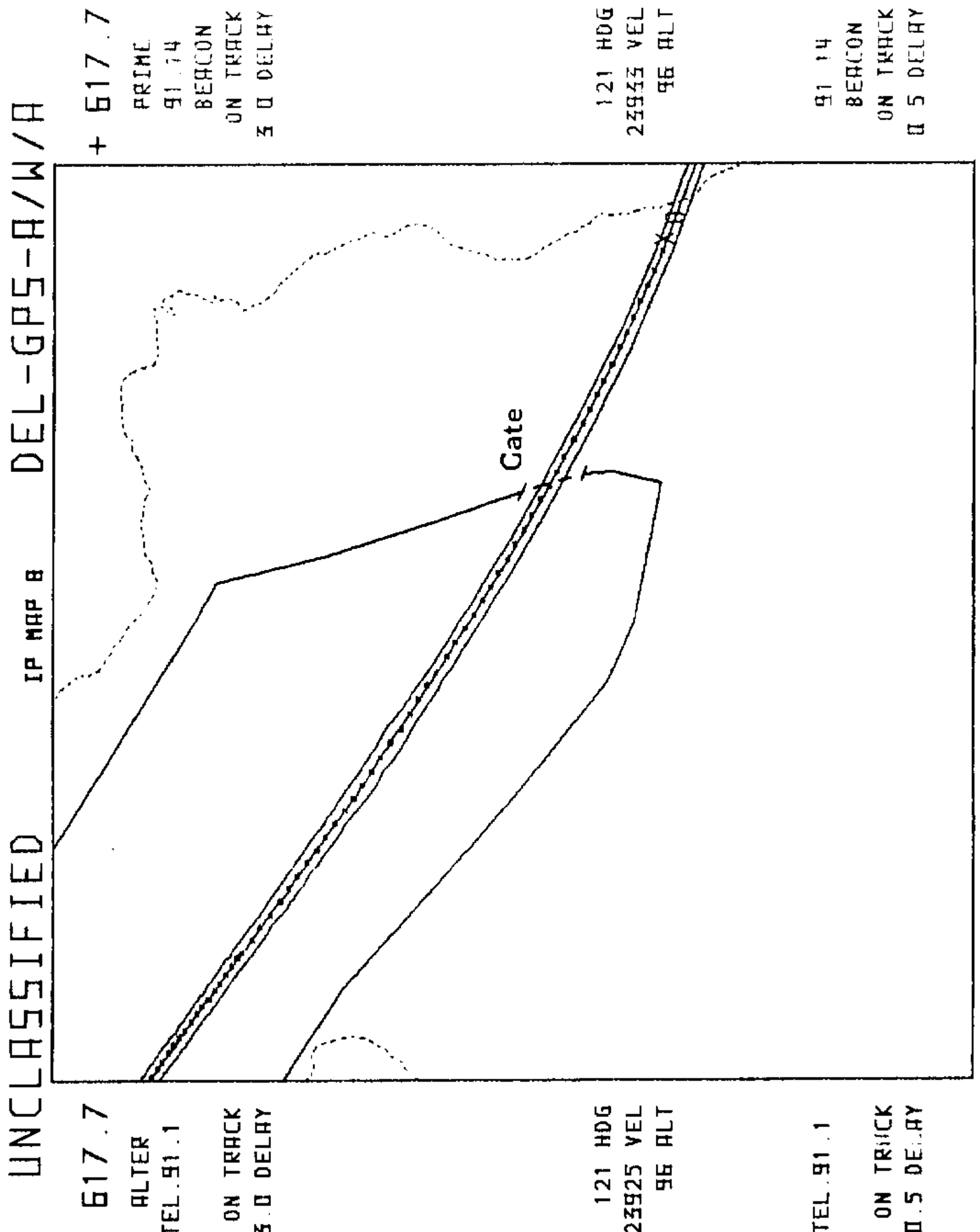


Figure 2 - 8: Example IIP Chart with Gate

2.4.2.7 Flight Safety Data

The range user must provide data to SEO that can be used to process a Flight Plan Approval request and prepare the safety criteria for the launch of a vehicle. AFSPC 80-12 (Draft), Standard Theoretical Trajectory Magnetic Tape Format, lists specific digital data requirements, coordinate systems, time intervals, and the precision required of the trajectory data for space and ballistic vehicles. The lead times (see Table 2-1) and procedures required for submitting data to SEO are included in EWR 127-1. Data required fall into three groups: digital trajectory data, vehicle turning rates, and vehicle breakup data. Additional information required include descriptions of the performance capability of the vehicle that does not lend itself to a digital format. Examples of such performance information could be typical vehicle failures, reliability of stages, and payload description.

- Digital Trajectory Data. The purpose of the different trajectories (nominal, three-sigma right, three-sigma left, steep, and lateral) that are provided to SEO is to identify an expected vehicle track or trajectory (referred to as nominal) and the spatial bounds of a vehicle performing within normal limits. Position data that are presented on launch-area, vertical-plane, present-position displays define the region of user-described normal vehicle performance. Instantaneous Impact Points may be used in addition to position data for some vehicles. The three-sigma lateral (right or left deviation) impact points define vehicles performing within normal limits in the downrange area. These data are presented on IIP displays for comparison to the actual track of the vehicle.
- Vehicle Turning Rates. If the MFCO decides to terminate the flight of the vehicle, there are system delays, such as time to transmit destruct signal, that must be considered to safely contain the vehicle impact point. As a result, there is a time delay that may occur during flight in which the vehicle's impact point may deviate prior to destruct. System delays affect the displayed position as the MFCO monitors the downrange flight of a vehicle. The region of possible impacts can be defined if the maximum angle that the velocity vector can turn through at any time in flight is known. This established the requirement for vehicle maximum turn rates.
- Vehicle Breakup Data. The breakup of a vehicle is significant in the preparation of destruct criteria. The analyst must model the entire breakup configuration with a relatively small number of debris classes. Pieces, such as bottles, motors, and propellant chunks can explode upon impact and cause hazardous overpressures or fragments that cover a large area. Inert pieces can have different velocities imparted to them by pressure release or explosion. A further problem, especially in the launch area, is establishing the limits of protection for lighter pieces that may drift considerably in the presence of winds. Depending on the pieces selected to represent the vehicle breakup; it may be necessary to set constraints on the wind velocity and direction at the time of launch.

2.4.2.8 Operational Hazard Areas

Vehicles that malfunction during the minus count and the early stages of flight endanger Land areas around the launch pad. Sea areas are similarly endangered by non-nominal vehicles and by the impact of spent stages from nominal vehicles. SEO identifies the endangered areas, quantifies the associated risks, and implements procedures to, where practicable, limit access of people, ships, and aircraft. Notice to Airman and Mariners, defining the affected areas, are published in hazardous area notices, and the function of the Surveillance Control Officer is directed toward reducing the traffic subject to risks in these areas.

2.4.2.8.1 Flight Hazard Area (FHA)

The FHA is a ground area determined by SEO analysts and based on calculated explosive velocities, TNT equivalents, and overpressure from malfunction of a vehicle on the launch pad or in the early phase of flight. The area is drawn as a circle around the launch pad extending to an unlimited altitude (a cylinder), and includes the entire area where the risk of serious injury, death, or substantial property damage is so severe that it necessitates exclusion of all personnel and equipment not needed to support the launch operation (non-mission essential personnel). Personnel required to be in the FHA during launch must be located in blast-hardened and approved structures. An example of a FHA is shown in Figure 2-3.

2.4.2.8.2 Flight Caution Area

The Flight Caution Area (FCA) is a controlled hazardous ground area, described by SEO, located outside the Flight Hazard Area that cannot be protected from a malfunctioning vehicle. The blast effects, described above, will propagate farther as the vehicle rises and programs downrange, exposing more land area around and under the trajectory between the pad and the ocean. The absence of early and accurate tracking data and the sum of the processing and display delays, plus the MFCO reaction time, are factors in the size and shape of the Flight Caution Area. The FCA is restricted to only mission-essential personnel during launch operations. An example of a FCA is shown in Figure 2-3.

2.4.2.8.3 Launch Danger Zone (LDZ)

The LDZ is a sea and air space extending from the launch point downrange, centered along the intended launch azimuth for a specified distance (typically 50 nautical miles). The size (length and width) of the LDZ is based upon the potential hazard to sea traffic. SEO provides the charts to plot targets and probability contours to show the risks to boats and ships in and approaching the Launch Danger Zone. Launch can be delayed if individual or combined risks to shipping are determined to be greater that 1×10^{-5} from launch area boat and ship hit contours. Notices to Airmen and Mariners (NOTAMS, NTMs) are issued defining the areas and associated airspace for sea and air traffic. Vessels and aircraft are advised to remain clear of these areas during the specified time. In addition, copies of ER's hazardous areas are furnished to the US Coast Guard marine safety office in Jacksonville, FL, for distribution to the Port Canaveral Coast Guard station and other marine interests in the Cape Canaveral area.

2.4.2.8.4 Spent Stage and Reentry Body Impact Areas

In addition to the areas that are endangered by a malfunctioning vehicle, there are areas where spent stages and reentering bodies from normally-performing vehicles will impact close enough to the launch pad that surveillance of the impact area can be performed by radar and aircraft from the CCAS. The Surveillance Control Officer monitors these launch area hazards. In other cases, the impact areas are located too far out for air or surface surveillance. Notices to Airmen and Mariners advise air and sea traffic to remain clear of the defined impact areas for the time period specified in the notice.

2.4.2.8.5 Hazardous Area Notices

SEO sends a letter to 45 RANS/DO (Range Scheduling) defining the hazardous areas for each launch. The letter gives the geodetic coordinates and distances for air and sea areas and the times that aircraft and vessels should remain clear of these areas. The letter also specifies the areas to be closed to unauthorized air traffic. The 45 RANS/DS sends NOTAMS and NOTMARS to all concerned agencies including foreign governments, if applicable. Figures 2-9 and 2-10 are plots of uprange/launch area warning areas.

Designated uprange aircraft control areas include:

- Restricted areas over CCAS and KSC (2932, 2933, 2934, and 2935);
- Warning areas (W-497A and W-497B).

Both Uprange (launch area) and downrange areas for aircraft and ships are as specified in the NOTMAMS and NOTMARS.

2.4.2.8.6 Collision Avoidance (COLA)

The COLA computer program is used to support space vehicle and ballistic launches where the trajectory of the launch vehicle and its components or stages could endanger an object capable of being manned. The purpose of the program is to ensure the safety of an orbiting, manned spacecraft against collision with a vehicle being launched. Inputs to the COLA program include a trajectory of the launch vehicle; an element set of the orbiting vehicle and miss distance desired. The trajectory of the launch vehicle is computed from vectors and required time intervals supplied by SEO. The element set of the orbiting vehicle is usually received from NORAD. More accurate element sets for STS launches can be obtained from Johnson Space Center. The trajectory and the element set are input to the COLA program that computes the closest approach of launch vehicle and orbiting spacecraft.

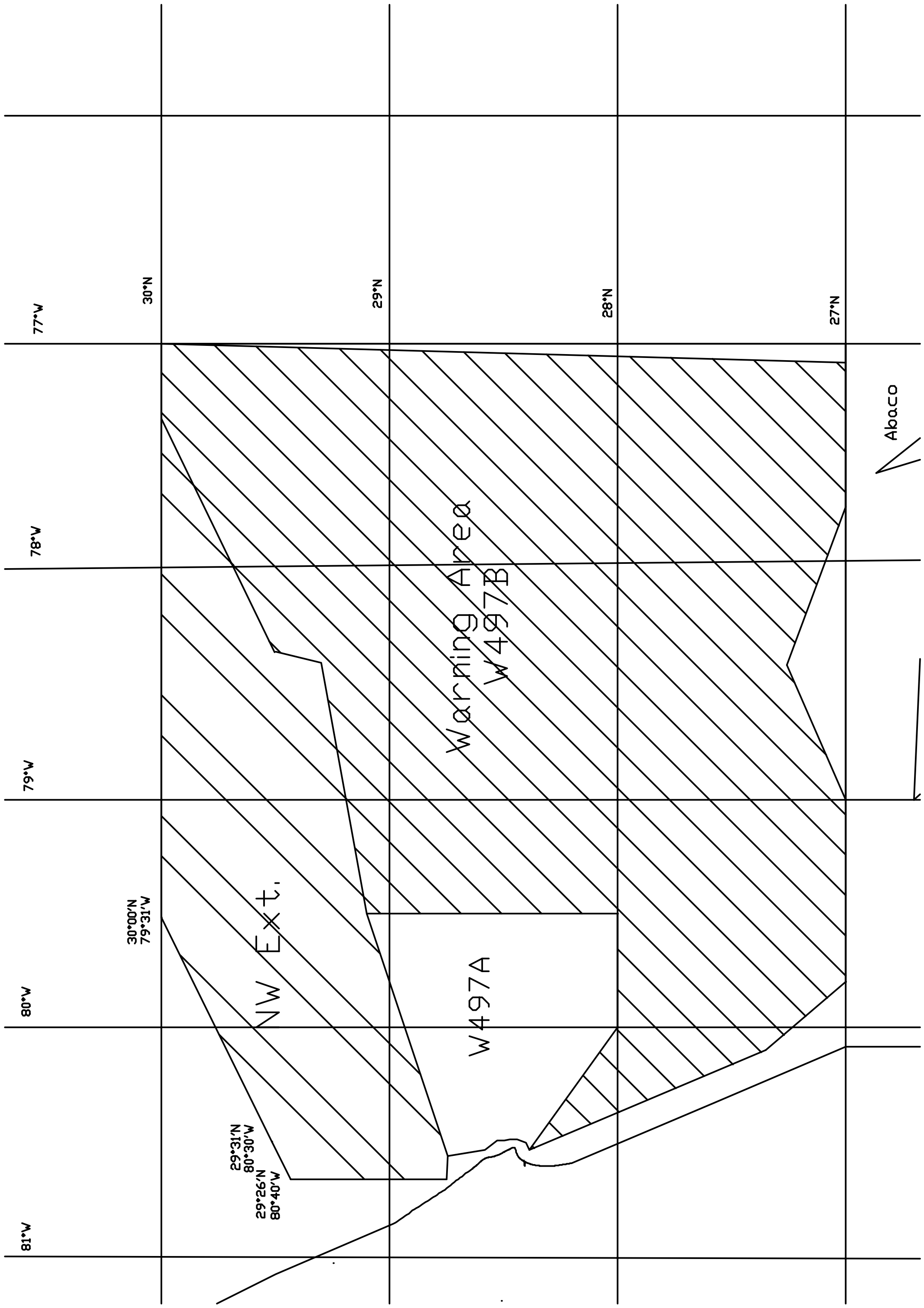


Figure 2 - 9: Example of Offshore Warning Areas

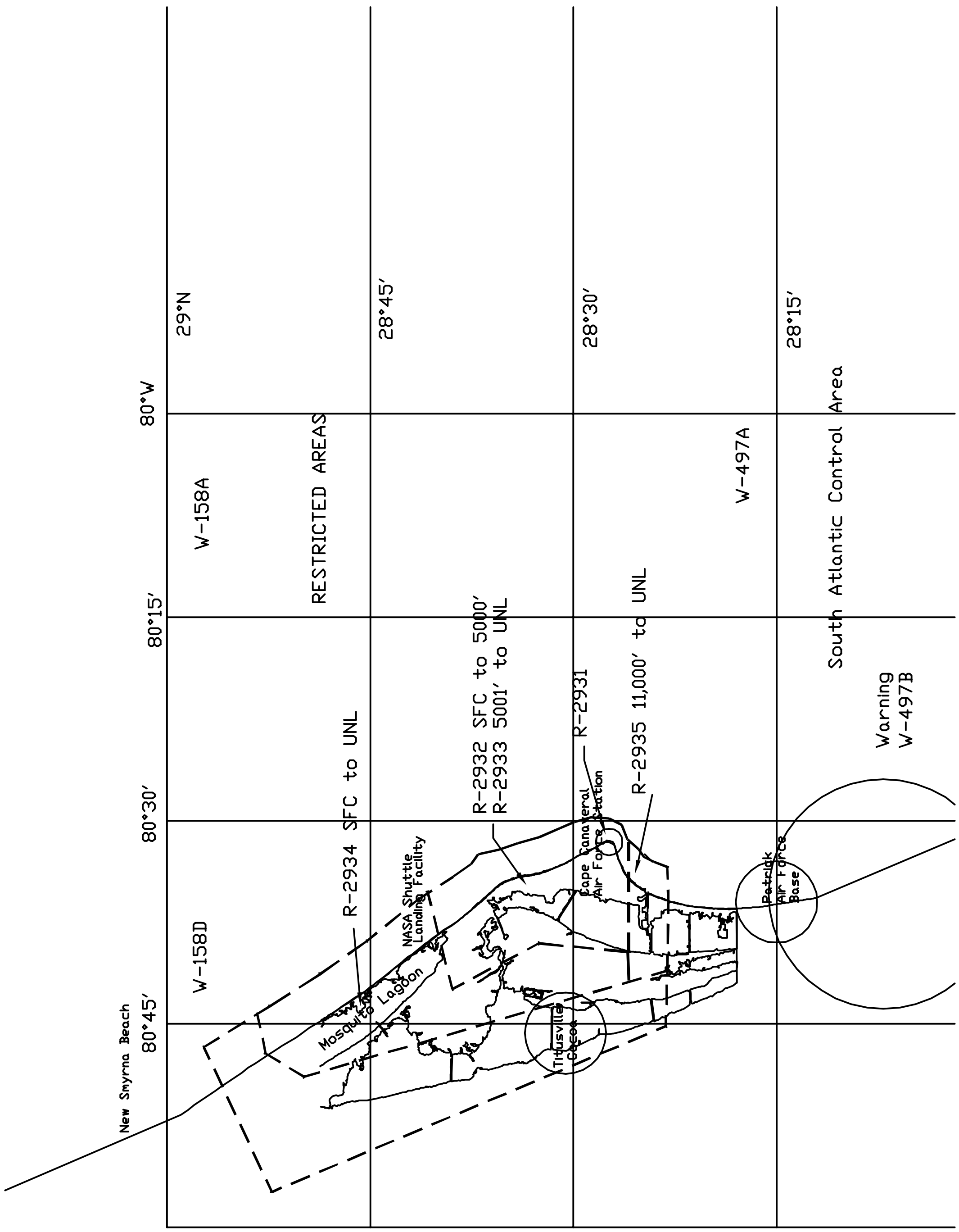


Figure 2 - 10: Example of Launch Area Restricted Areas

COLA provides Range Safety information to ensure that any launch from the ER comes no closer than specified distances to manned spacecraft. The parameters used by SEO are that the separation from a manned spacecraft is 200 kilometers. The COLA computed no-launch intervals are extended to account for uncertainties in the launch-vehicle trajectory and for possible maneuvers by the manned spacecraft.

2.4.3 Non-Compliance with Range Safety Requirements

Deviations or waivers to EWR 127-1 may be allowed when mission objectives cannot otherwise be achieved. These will be granted only under unique or compelling circumstances. The ER policy is to avoid the use of deviations or waivers except in extremely rare situations. Range Users are responsible for identifying all non-compliance's with this document to Range safety for resolution. Range safety and the Range user shall jointly endeavor to ensure that all requirements of this document are met as early in the design process as possible to limit the number of required deviations and waivers to an absolute minimum. Non-compliances and their processing are explained in detail in Section 1.6.5 and Appendix 1C of EWR 127-1.

2.4.3.1 Types of Non-Compliance's

2.4.3.1.1 Deviations

Deviations are used when a design noncompliance is known to exist prior to hardware production or an operational noncompliance is known to exist prior to beginning operations at the Ranges.

2.4.3.1.2 Waivers

Waivers are used when, through an error in the manufacturing process or for other reasons, a hardware noncompliance is discovered after hardware production, or an operational noncompliance is discovered after operations have begun at the Ranges.

2.4.3.1.3 Meets Intent Certification

Certifications (MICs): MICs are used when Range users do not meet exact EWR 127-1 requirements but do meet the intent of the requirements. Rationale for equivalent safety shall be provided. MICs are normally incorporated during the tailoring process.

2.4.3.2 Categories of Non-Compliance

2.4.3.2.1 Public Safety

Public safety noncompliance deals with safety requirements involving risks to the general public of the US or foreign countries and/or their property. Only the Wing

Commander or his/her designated representative shall approve non-Compliance's effecting Public safety.

2.4.3.2.2 Launch Area Safety

Launch area safety non-compliance's deal with safety requirements involving risks that are limited to personnel and/or property on CCAS and may be extended to KSC. Launch area safety involves multiple commercial users, government tenants, and/or squadrons.

2.4.3.2.3 Launch Complex Safety

Launch complex safety non-compliance's deal with safety requirements involving risk that is limited to the personnel and/or property under the control of a single commercial user, full time government tenant organization, or USAF squadron/detachment commander (control authority). Launch complex safety is limited to risks confined to a physical space for which the single control authority is responsible.

2.4.3.3 Effectively of Non-Compliance's

2.4.3.3.1 Lifetime

Lifetime MICs are allowed provided equivalent safety is maintained. When granted, deviations and waivers are normally given for a defined period of time or a given number of missions until a design or operational change can be implemented. Lifetime deviations and waivers are undesirable.

2.4.3.3.2 Time Limited

Time limited deviations and waivers are set for a limited period of time or a limited number of launches. The time constraint is normally determined as a function of cost, impact on schedule, and the minimum time needed to satisfactorily modify or replace the non-compliant system or to modify the non-compliant operation. MICs may be time limited depending on the method by which equivalent safety is accomplished. If excessive procedural controls, personnel, material, or costs are required to maintain equivalent safety, the MIC should be time limited.

2.4.3.4 Conditions for Issuing Non-Compliance's

2.4.3.4.1 Hazard Mitigation

All reasonable steps shall be taken to meet the intent of EWR 127-1 requirements and mitigate associated hazards to acceptable levels, including design and operational methods.

2.4.3.4.2 Get Well Plans

All MICs, deviations, and waivers that are not granted for the life of a program shall have a plan to meet the requirements in question by the time the approved effectively expires.

2.4.3.4.3 National Need Rationale

Rationale for national need or mission requirements shall be explained.

2.4.3.5 Submittal of Non-Compliance's

2.4.3.5.1 Submittal Format

All non-compliances shall be submitted in writing in letter or memorandum format or the equivalent. An example format may be found in the Range User Handbook. The details for content of a non-compliance request are discussed in EWR 127-1 Section 1C.2.2.

2.4.3.5.2 **To Whom Submitted**

Requests for MICs, deviations, and waivers shall be submitted to the Office of the Chief of safety as early as they are known to be necessary.

2.4.3.5.3 MICs, Long Lead Time Submittals

Deviations, and waivers such as those including flight plan approval, flight termination system design, and toxic propellant storage normally require extensive risk analyses that can take one to two years to perform; therefore, these deviations, MICs, and waivers shall be initiated during the planning phase and be closed out by Range approval or design change prior to manufacture of the booster, spacecraft, flight termination system or other system in question.

2.4.3.5.4 Submittals for Launch Site Safety and Launch Complex Safety

Launch site safety and launch complex safety MICs, deviations, and waivers normally require two weeks to two months to process depending on the nature of the non-compliance and the requested effectively.

2.4.4 Reviews

System Safety (SES) must be notified of all System Requirements Reviews (SRRs), System Design Reviews (SDRs), Preliminary Design Reviews (PDRs), Critical Design Reviews (CDRs), Phase Safety Reviews, or any system/program concept meetings involving safety critical systems, hazardous operations, and facility design/modifications so that Range Safety input can be incorporated.

2.4.4.1 Range User/Range Safety Interface Process

This section covers the range user/Range Safety interface process used to ensure that only those portions of EWR 127-1 that are directly applicable to a given program's specific needs are emphasized, and that both Range Safety and the range user understand the requirements and reach mutual agreement on compliance methods early in the program.

The interface process must commence during the concept phase of a program in order to ensure early Range Safety participation and resolution of safety issues. Time line and event schedules will vary depending on the complexity of the program. Figure 2-11 provides a general schedule and time line of events as guidance for major launch vehicle programs. For small vehicles, these time lines can be compressed down to approximately one year or less, depending on whether new or previously approved hardware is involved. Spacecraft and satellite time line and event schedules differ significantly from launch vehicles and are covered in the following section and in Figures 2-12 and 2-13.

2.4.4.1.1 Initial Interface

Potential range users may make initial contact with Range Safety prior to officially submitting a program introduction document. It is recognized, particularly for commercial programs, that initial contact with Range Safety may be necessary during the commercial booster/payload customer contract negotiations. The purpose of these meetings is to clarify program concepts, determine whether specific flight profiles can be accommodated, and to determine whether there are any major safety concerns which could impact the program.

2.4.4.1.2 High Performance Work Team (HPWT)

Once a Program Introduction has been accepted by the range, Range Safety initiates a meeting with the prospective range user to establish a High Performance Work Team. When the user decides and officially notifies the range that they will use the ER, the work team is activated. The goal of the HPWT is mutually acceptable, tailored requirements. In those situations where mutual agreement is not achieved, an appeal to the next level of ER organizational responsibility is heard. The appeal channels follow the management and functional organizational arrangement. The team's task includes the following:

- Definition and identification of all hazardous systems associated with launch vehicle and/or payload (spacecraft);
- Description of vehicle flight path in terms of azimuth and trajectory;
- Definition of launch vehicle configuration, performance characteristics, and program mission requirements;

SCHEDULE OF EVENTS

FOR NEW MAJOR LAUNCH VEHICLES

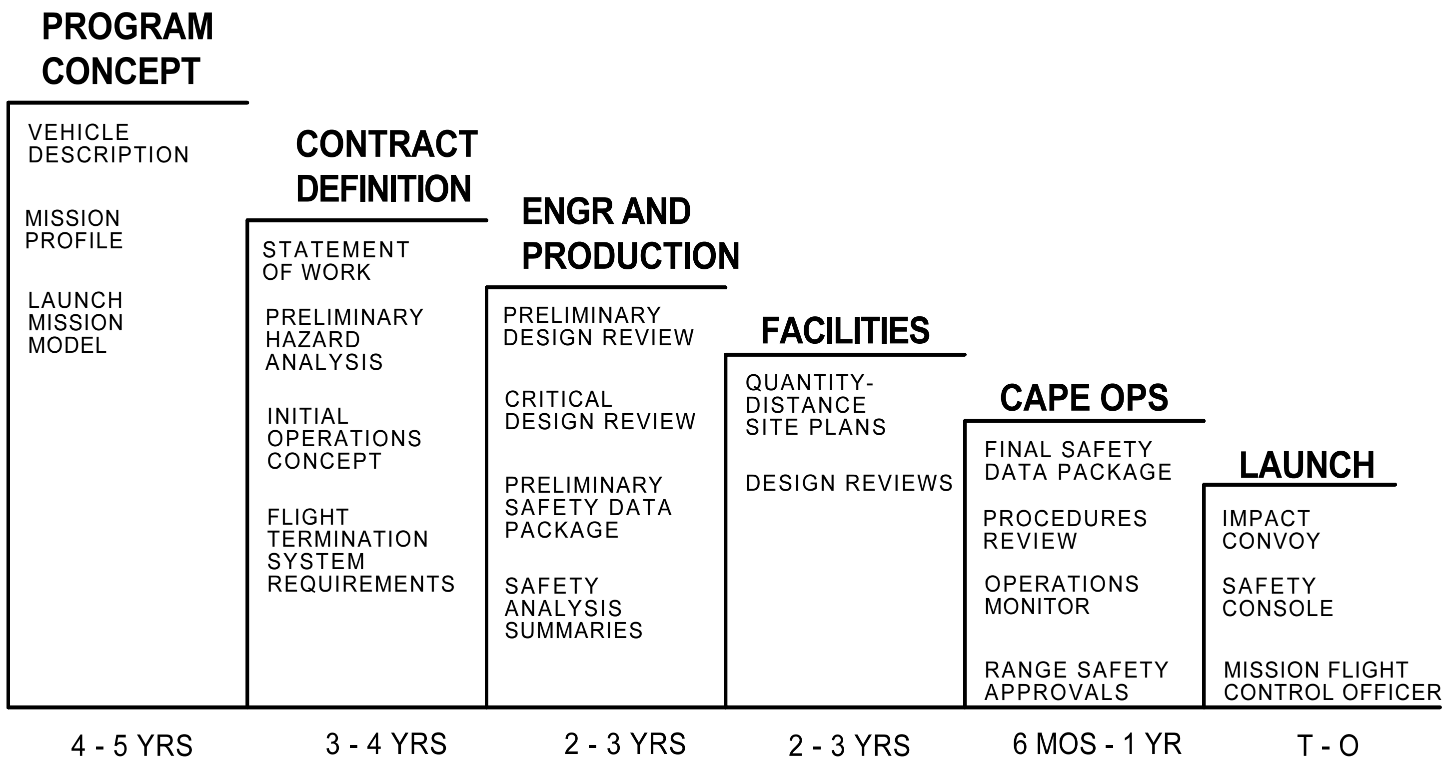


Figure 2 - 11 Schedule of Events

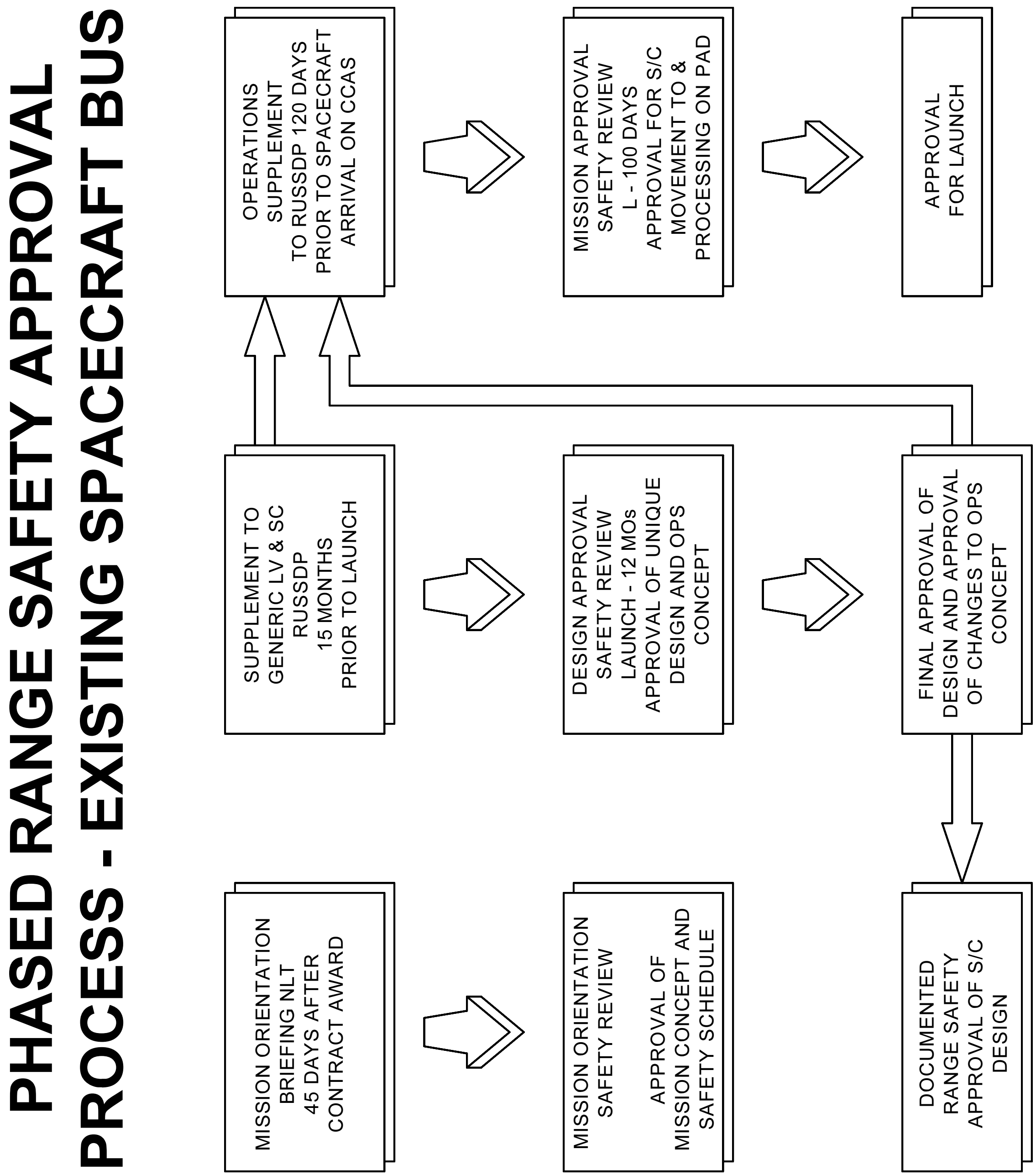


Figure 2 - 12: Phased Approval for Existing Spacecraft Bus

PHASED RANGE SAFETY APPROVAL PROCESS - NEW SPACECRAFT BUS

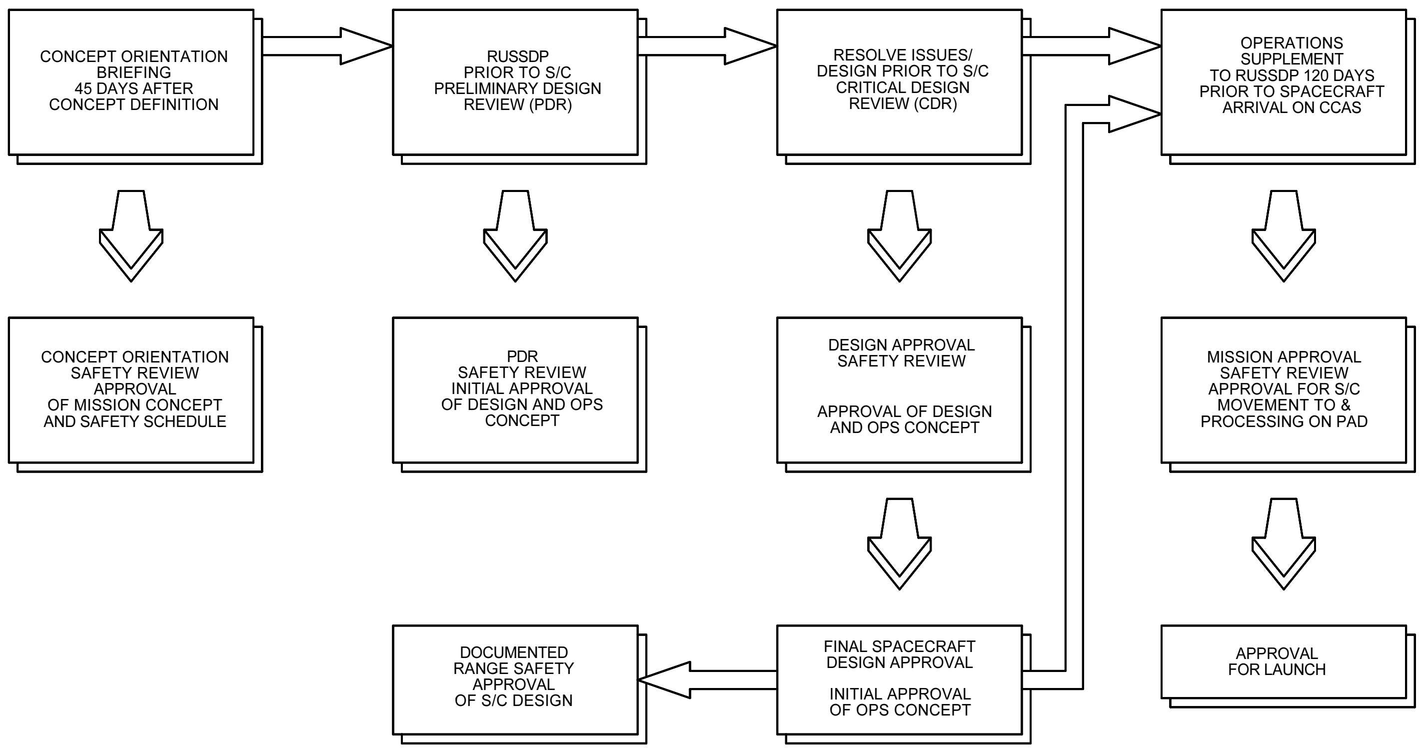


Figure 2 - 13: Phased Approval New Spacecraft Bus

- Failure modes and failure probabilities of the launch vehicle and/or payloads;
- Definition and description of facilities required, including launch complex, hazardous assembly and checkout areas, and ordnance and propellant storage requirements;
- Based on the results of the initial HPWT evaluation, each chapter of EWR 127-1 is tailored to specific requirements for the mission. The tailoring effort progresses and becomes more detailed as program definition phase moves from concept through preliminary and critical design reviews. The HPWT establishes a documented EWR 127-1 tailored baseline, which is used throughout the life of the program and is modified as new data is available and modifications are made. The baseline documents each EWR 127-1 requirement;
- Documentation is maintained by the team regarding agreements, problem issue closeouts, waivers, deviations, and 'meet the intent' decisions.

Membership on the High Performance Work Team includes Range Safety representatives responsible for flight termination system design, flight plan approval, destruct criteria development, system safety, and facilities design. Depending on size and scope of the mission and/or the program, Range Safety membership can range from one to four individuals. The range user is requested to provide participants who are familiar with, and responsible for, development of the FTS, launch vehicle and payload configuration, vehicle performance characteristics, failure modes, breakup parameters, operational flow process, facility requirements, and launch vehicle hazardous systems. This could require participation from three to ten individuals from the user organization. Each new program is defined from the concept phase through the critical design review, and includes the following:

- Complete vehicle description, including number of stages, type of propellants, payload (spacecraft) description, type of guidance system, and planned number of launches;
- Vehicle performance and mission characteristics;
- Planned launch azimuth and trajectories are provided in a preliminary form as soon as possible and modified as more detail is available. Vehicle thrust and weight ratios, and acceleration parameters are defined;
- Turn rates, Q, malfunction time, and breakup characteristics are developed and defined. Breakup characteristics based on failure modes and failure probabilities are developed;
- Vehicle flight plans are defined in terms of azimuth and trajectory, acceleration and velocity, and identification of landmass overflight;
- Requirement for risk assessment is defined, and schedules developed to determine need dates;
- Destruct criteria, mission rules, and FTS requirements are defined, and FTS requirements are tailored to meet specific programs. The tailored version will be

used in the design, qualification and acceptance tests, data submittals, and Range Safety review and approval.

2.4.4.2 Generic Spacecraft Approval Process

The phased Range Safety approval process shown in Figure 2-13 is used for new spacecraft and satellite buses. The goal is to grant baseline approvals for generic buses during the first mission. Subsequent flights will use a joint assessment process (Range Safety, spacecraft manufacturer, and launch vehicle company) to review and approve changes to the generic bus and/or payload additions for specific missions. Using the approval process outlined in Figure 13, the following process and time line guidance is provided.

- A concept orientation briefing is provided to Range Safety early in the conceptual phase of the development. The generic approval process is documented and concept approvals granted so that an audit trail can be established. A concept orientation safety review is held in conjunction with this briefing and approval of design concepts, schedule of safety submittals, and Range Safety responses are documented. Range Safety concept approvals not granted at this meeting will be provided within 10 working days.
- A Preliminary Design Review is held at least 12 months prior to scheduled launch and serves to provide necessary data for the initial Range Safety approval before the final spacecraft design and prelaunch processing is initiated. Range Safety provides approvals within 30 working days after the meeting.
- A Critical Design Review is held prior to initiating hardware manufacture. This review provides Range Safety the necessary data to grant final design approval and prelaunch processing initial procedure review. Range Safety will provide response within 30 working days after the meeting.
- A mission approval safety review is conducted approximately launch minus 120 days to obtain Range Safety approval for booster processing, transport to the spacecraft launch pad, spacecraft/launch vehicle mating, and launch pad spacecraft processing. Unless there are significant issues, Range Safety will provide mission safety approval ten working days after the safety review.
- Final approval to proceed with launch vehicle and spacecraft processing up to commencing the final countdown is provided by Range Safety at least 60 days prior to spacecraft arrival at the launch complex. Flight plan approval for a high inclination launch that involves public safety may require extensive risk analyses and may not be granted until just prior to the Launch Readiness Review, depending on the complexity of the public safety issue encountered. Typically, easterly launch azimuths can be approved very early (at least 120 days prior to launch).
- Incidental Range Safety issues (component failures, test failures, and discovery of unforeseen hazards) occurring following baseline approvals, are worked in real-time as part of the final approval process for an individual launch. Typically, these issues involve the launch vehicle, not the spacecraft.

- Additional response time for Range Safety will be required if data packages are incomplete, complex issues are uncovered, or data is poorly presented.

2.4.5 Range Safety Launch Operations

This section contains policies, identifies requirements, and provides procedures used by Mission Flight Control Officers, acting for the Eastern Range Commander, to maintain positive control of ballistic launch vehicles and space vehicles launched on the Eastern Range.

2.4.5.1 Range Safety Operations Responsibilities

The MFCO is responsible for in-flight safety that includes taking all necessary precautions to minimize the risks to life and property, while not unduly restricting a non-nominal vehicle that has not violated flight termination criteria. Air Force officers and DOD civilians serve as MFCOs. In addition to the two MFCOs manning the safety console in the Range Operations Control Center (ROCC), there are supporting MFCOs at the vertical wire skyscreen, telemetry console, command console, and at the Surveillance Control Officer position. Additional MFCOs may be on board ships and in helicopters or aircraft as required.

The capability to ensure launched vehicles do not violate approved flight rules is imperative for the public safety; therefore, the primary responsibility of the MFCO is to monitor the progress of a launched launch vehicle or space vehicle and determine if its flight should continue or be terminated. The MFCO will normally take flight termination action under the following conditions.

- Obviously Erratic Flight - Vehicle performance is such that the potential exists for loss of flight termination control as the result of a gross flight deviation or obviously erratic flight, and further flight is likely to increase the hazard potential. This action may be taken even though the launch vehicle has not violated the flight termination lines.
- Flight Termination Line Violation - Valid data show that the launch vehicle flight violates a flight termination line.
- Performance Unknown - Launch vehicle performance is unknown and the capability to violate a flight termination line exists. If launch vehicle performance has been normal after launch for an extended period of time prior to becoming unknown, the MFCO, after consultation with the Senior MFCO, may allow the flight to continue.
- Mission Rules - At the request of the range user.

Flight termination, for liquid-fuel boosters, consists of fuel cutoff (arm command) followed by destruct (destruct command). In some cases, such as the range user's requirement to collect as much data as possible, destruct action may not be required after engine shutdown (thrust termination) has been confirmed, and impact of the vehicle is calculated to be in the broad ocean area. For solid-propellant boosters, there is no means to terminate thrust except to send the destruct command.

2.4.5.2 Clearance

Launch area surveillance encompasses those land, air, and sea areas designated as the Flight Caution Area and Launch Danger Zone for a launch. The MFCO ensures that these areas are clear or that the probabilities of being hit by debris or exposed to overpressure are within acceptable limits for aircraft, surface vessels, and personnel within these areas. This determination is made prior to giving a "Clear to Launch". The Operations Safety Manager is responsible for clearing the Flight Caution Area and reporting the area clear to the MFCO. This report is made at a designated time in the launch countdown.

Warning signals are displayed when the Launch Danger Zone is closed at L-60 minutes. In addition, marine radio broadcast warnings are made to inform vessels of the effective closure times for the sea Launch Danger Zone.

Control of air traffic in Federal Aviation Administration-designated areas around the launch head is maintained by coordination between the Surveillance Control Officer, the Aerospace Control Officer, and Miami Air Route Traffic Control Center (ARTCC) to ensure that aircraft are not endangered by launches, nor launches delayed by the presence of aircraft.

2.4.5.3 Surveillance

Fixed wing aircraft support for surveillance control is normally required for STS launch operations and may be required for other unique launches. Aircraft must be available for the duration of the launch window and are controlled by the Surveillance Control Officer (SCO) during surveillance operations.

One or more helicopters are normally required to perform sea surveillance of the Launch Danger Zone for all launches from CCAS and KSC. They are also used, when possible, to support offshore launches. The helicopters are available for surveillance operations no later than L-90 minutes prior to launch.

The RAPCON radar at Patrick AFB and the ARTCC radar are used to support pad and offshore launches. They provide surveillance for intruding aircraft within a 50 nautical mile radius of the launch point, beginning no later than L-30 minutes and continuing until released by the SCO. Contacts are reported by speed, heading, and bearing from a known reference point, and estimated time to clear the warning areas. In addition, the FURUNO radar is used for sea surveillance during pad launches. They are available from L-120 minutes until released by the SCO.

Launch area surveillance charts and ship/boat contours used for SCO plotting are provided by SEO (see Figures 2-14 and 2-15). During launch operations, the SCO displays any reported surface vessel and support aircraft positions on the surveillance plotting board. Communications links between the SCO and the MFCO, ACO, surveillance radar operators, supporting surveillance aircraft, and the US Coast Guard Station (USCG), Port Canaveral, are required.

USCG support includes:

- periodic warning broadcasts no later than L-4 hours, repeated every hour until T-0, to advise vessels to remain clear of the Launch Danger Zone;
- at least one USCG patrol vessel positioned at the entrance to Port Canaveral, no later than L-60 minutes, to warn other vessels leaving the port to remain clear of the Launch Danger Zone;
- marine radio communications capability to contact endangered vessels, warn them, and provide instructions for clearing or avoiding the Launch Danger Zone; and
- a liaison officer in the SCO area to coordinate USCG support on launch day.

2.4.5.4 Weather

For all major launches from CCAS and KSC, the Cape Canaveral Forecast Facility (CCFF) provides the SEO representative assigned to the launch with a forecast of launch winds on F-1 day, on launch day, and at other times during the launch when requested. In developing wind forecasts, the latest available balloon data and met-rocket data are combined to produce the best possible estimate of T-0 winds. After the wind forecast has been established on disk file, a CCFF meteorologist discusses the degree of confidence in the predicted winds with SEO personnel. The likelihood of any changes in wind speed or direction before the launch, and the magnitude of any such changes, is also discussed. As a result of this briefing, SEO determines whether additional wind observations will be required. If the wind forecast should subsequently change because of launch delays or other circumstances, the meteorologist informs the MFCO and SEO representatives immediately. Estimates of quantitative changes in wind speed and direction as a function of altitude is provided. At L-60 minutes, the CCFF provides a weather forecast briefing for the launch area using closed circuit television and direct line or network communications.

In addition, there are two computer programs that use current data to predict whether the weather is suitable for launch.

- BLAST is a program that uses current weather to determine whether certain meteorological conditions are suitable for launch or could cause catastrophic overpressures in the event destruct action is necessary.

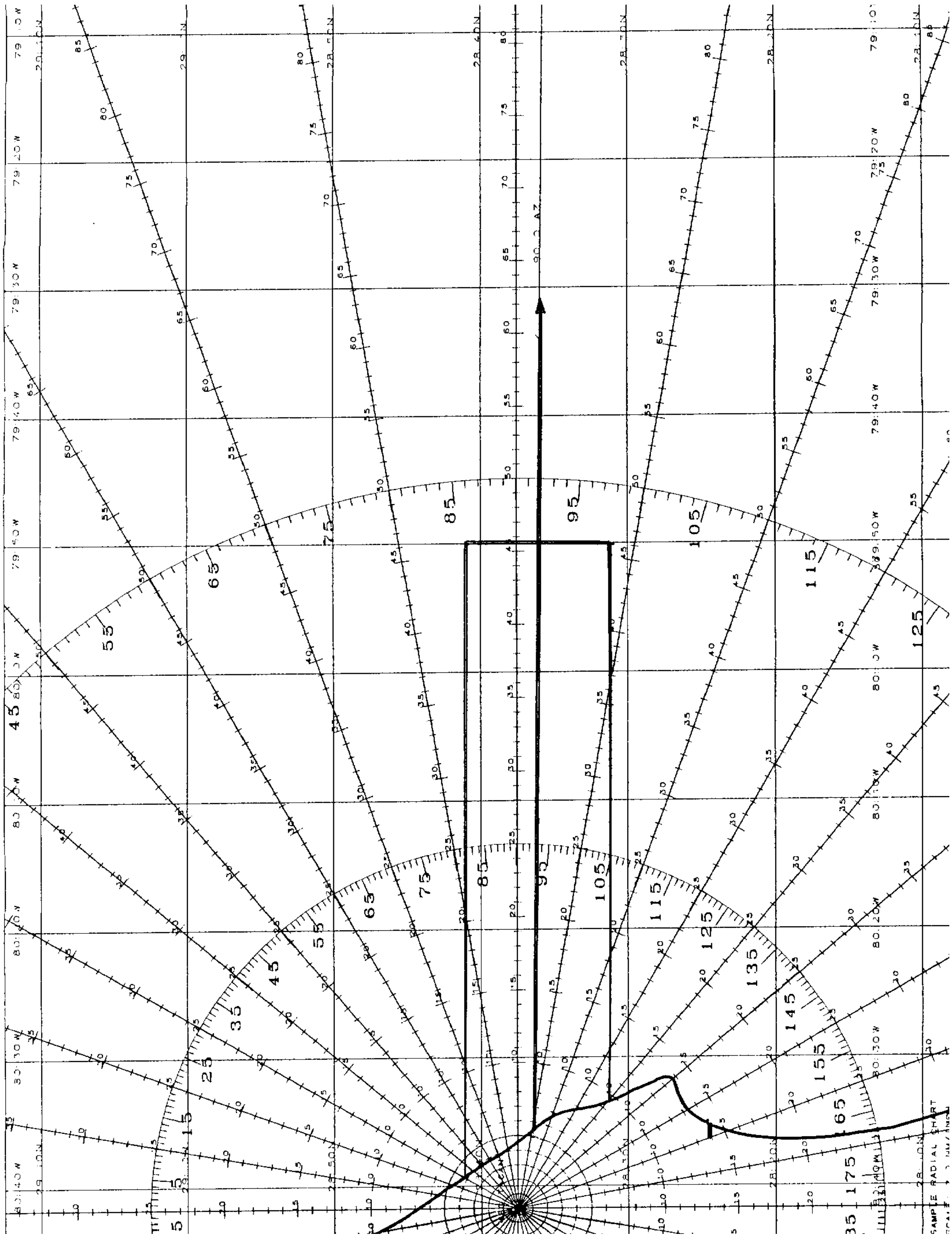


Figure 2 - 14: Example of SCO Plotting Chart

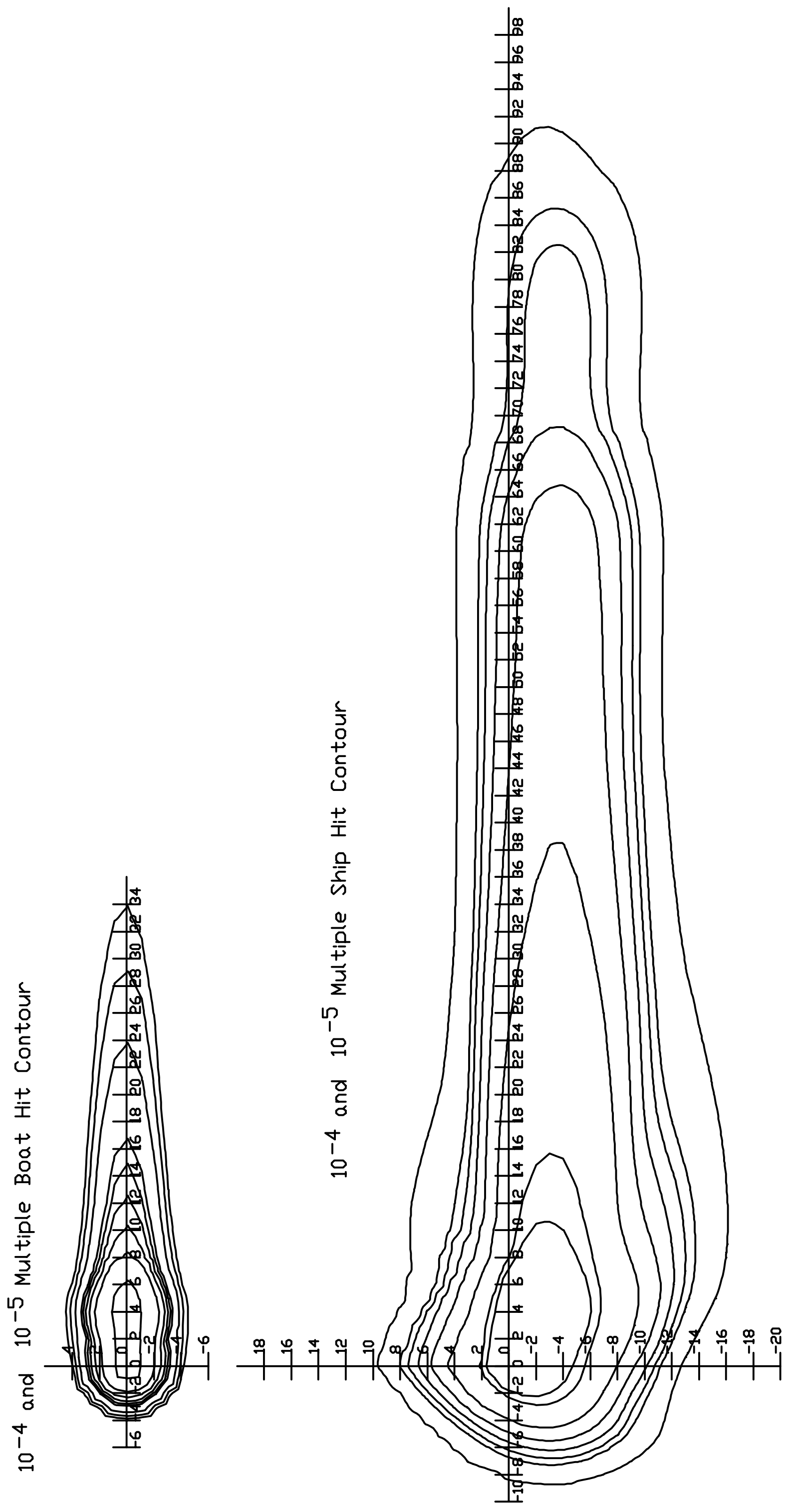


Figure 2 - 15: Example of Multiple Boat/Ship Contours

- Meteorological and Range Safety Support, MARSS, is a system that uses current weather data to determine the downwind diffusion prediction in the event of a toxic spill.

2.4.5.5 Range Safety System

The Range Safety System consists of all equipment, software, and personnel required performing the Range Safety function for an operation. The MFCO must either be in position to see the data displays or be in communication with safety support personnel who are observing the data. The information must be presented in a format that is simple to evaluate, available in a timely manner, and communicated such that the MFCO is not over-saturated with data.

2.4.5.5.1 MFCO Console

The MFCO console has six high-resolution color monitors, video monitors, communication and timing panels, and flight termination switches. The console has two operating positions, one for the MFCO and one for the Senior Flight Control Officer. Each MFCO can independently select the data and display to monitor throughout flight.

2.4.5.5.2 Instrumentation

Range instrumentation data sources provide the MFCO with real-time information on launch vehicle behavior. Instrumentation is designed to ensure that no single-point-of-failure, hardware or software-related, will deny the MFCO the capability to directly monitor a launched vehicle's flight. When possible, Range Safety critical instrumentation is designed to allow single failures in hardware, and still provide overall system redundancy. Track from at least two adequate and independent data sources is mandatory and will be maintained throughout each phase of powered flight or until orbital insertion of the vehicle. An analysis is done to help the MFCO know if the vehicle has reached the no-longer-endanger (NLE) line. The NLE for suborbital missions is defined as the time or position on the nominal trajectory at which the vehicle no longer has sufficient energy to endanger areas outside the impact limit lines. After the NLE is reached, destruct action is not required if track is lost. For orbital missions, which typically involve overflight of land shortly before orbital injection, it is customary to establish a gate in the destruct line through which the vehicle's impact trace must pass to avoid destruct action. The NLE is defined as the time in flight when the time required for the impact point to travel along the nominal trajectory to the overflight gate is less than the travel time to all other points along the boundary lines. If the vehicle arrives normally at the NLE, and track is subsequently lost, no destruct action is taken. Withholding destruct in such cases assures that a vehicle will not be intentionally destroyed while the impact point is traversing land or the vehicle is in orbit.

2.4.5.5.3 Range Tracking System

EWR 127-1 requires a Range Tracking System (RTS) that is comprised of the hardware, software, and manpower required to transmit, receive, process, and display launch vehicle data required for Range Safety purposes. An RTS, including at least two adequate and independent instrumentation data sources, is mandatory and shall be maintained from T-0 throughout each phase of powered flight up to the end of Range Safety responsibility.

2.4.5.5.4 Vertical Wire Skyscreen (VWSS)

A Vertical Wire Skyscreen sighting apparatus, manned by a Forward Observer assigned to SEO, will be required for all pad launches. Range contractor technicians must complete the leveling and alignment of this apparatus no later than L-60 minutes.

Flight line and program television skyscreen systems are also required for all pad launches and are placed in operation no later than L-45 minutes. The program camera is fixed in azimuth, but free to track in elevation. A vertical reference line and arrow indicating planned direction of flight is superimposed on the TV transmission to monitors at the MFCO console positions.

2.4.5.5.5 Telemetry

The MFCO is also presented with real-time vehicle performance and impact prediction data derived from telemetry. Real-time telemetry of launch vehicle guidance data (state vector), if available, is used to generate an impact point for the MFCO. Specific telemetry display requirements are listed in the Range Safety Operations Requirements document (i.e., vehicle chamber pressure, roll, pitch, and yaw, and FTS status). The only specific telemetry requirements that apply to all vehicles are the FTS status requirements. On request, SEO is provided calibration data on the demodulated, telemetered performance of a launch vehicle by the range user.

2.4.5.5.6 Displays

The range contractor is responsible for the computation of solutions for present position and impact position and their display to the MFCO. The computation and display must be single failure tolerant. The prime displays are derived from range radar data and the alternate displays are derived from vehicle guidance state vector. Radar trilateration solutions are also required when available, however, this is not a hard requirement.

2.4.5.5.7 Functional Check

A complete end-to-end check of the Range Safety systems used to display data for flight control to the MFCO is made during the countdown using taped data, supplied by SEO no later than F-5 days, to simulate inputs from range radar, other tracking sources, and vehicle telemetry data. This functional check does not relieve the range contractor of responsibility for proper operation of the system during a launch.

2.4.5.6 Command System

The Command System, also known as the Command and Control system, is the ground portion of the flight termination system used during launch operations. It is comprised of ground transmitters at various sites throughout the Eastern Range (Cape Canaveral Air Station, Jonathan Dickinson Missile Tracking Annex (JDMTA), Antigua, Bermuda, Wallops Island, Virginia, and Argentia, Newfoundland) and the subsystems that support them.

2.4.5.6.1 Central Command Remoting System Operations Concept

During prelaunch preparation, the Central Command Remoting System (CCRS) is configured for the particular mission, using the configuration switches in the Command System Controller (CSC) configuration drawer and on the console. The FTU's are configured for the commands, such as setting Switch No. 1 as Arm and Switch No. 2 as Destruct. Autocarrier switch times are set, and supporting stations are configured on both the CSC and Range Safety Control and Display (RASCAD). After prelaunch checks are complete, no modifications to the switch settings are permitted.

During F-1 and launch day preparations, the CCRS is put through a complete system check. The CCRS supports all theoretical data runs, which includes bringing up the command carrier at the supporting command stations. Additionally, the CCRS performs switching checks with each supporting command station. These switching checks involve placing each of the CCRS Command Message Encoder Verifiers (CMEV's) and stations' subsystems online, radiating carrier, and modulating command functions.

After all prelaunch checks are complete; the key-lock switch in the CSC is set to lock out control from the CSC and turns over complete control of the system to the MFCO. From that moment on, only the MFCO's may turn on the carrier from RASCAD and request command functions from the FTU. The system will remain in that configuration until the CCRS has been released from the mission.

2.4.5.6.2 Command Sites Operations Concept

The Cape Canaveral Air Station (CCAS) Command sites operate in either local mode or remote mode. In local mode, a site retains control of the command carrier and functions. This mode is used for local site checkout only and is never used for operations. When the station is ready to support the operation, the site is placed in remote mode. This mode allows the operation of the site carrier and functions to be remotely controlled by the CCRS. The operating frequencies of the carrier are 406.5 Megahertz (MHz) for testing and 416.5 MHz for operations.

During F-1 and launch day preparations, the CCAS Command Station supports all theoretical data runs. For the CCAS station, this includes driving the steerable antennas and having the command carrier on at the station during the planned time of the launch. Additionally, the CCAS station performs switching checks with the CCRS. These switching checks involve placing each of the station's four subsystems (two High Power and two Low Power with each transmitter) with each CCRS CMEV online, radiating carrier, and modulating command functions.

After all prelaunch checks are complete; the station is placed in remote mode to lock out control by the station Operations personnel. Once in remote mode, site personnel are prohibited from returning to the Local mode by means of strict operational discipline. Complete control of the system is remoted to the CSC and MFCO. From that moment on, only the MFCO's may turn on the carrier from RASCAD and request command functions from the FTU's. The system will remain in that configuration until the station has been released from the mission.

2.4.5.7 Launch Operations

Preflight, countdown, and inflight launch vehicle operations are as follows (launch operations of the Lockheed Launch Vehicle (LLV) is used as a typical example).

2.4.5.7.1 Preflight Operations

During preflight operations, checkout of the command control system is completed by L-45 minutes. When these checks are completed, the Range Control Officer (RCO) confirms to the MFCO that the ground portion of the flight termination system is fully mission-capable. The MFCO then assumes full control of all command control systems. After the MFCO assumes control of the system, the Operations Safety Manager (OSM) will not allow the flight termination receivers to be turned on or off, and the RCO will not allow functions to be transmitted, without the specific approval of the MFCO. In case of misfire, hangfire, or mission scrubs, the receivers will be turned off in accordance with the appropriate checklist, which is developed by the range user and reviewed and approved by Range Safety.

The OSM provides the SES representative for the launch with results of launch vehicle flight termination system checks as soon as possible after they are conducted. The MFCO will not authorize launch until the SES representative confirms that the launch vehicle flight termination system is functioning properly. Proper operation of the flight termination system, as verified to and confirmed by the SES representative, includes the following:

- The command control system supporting a launch is checked out and is fully operational;
- The airborne flight termination system, when required, is checked out and is fully operational;
- All displays associated with the launch vehicle flight termination system and command control system are functioning properly at the MFCO console positions.

The OSM and /or the Operations Safety Technician (OST) are responsible for the following preflight action item requirements.

- To ensure proper operation, the holdfire and firing line interrupt capability is checked out at a mutually agreed upon time on the launch pad as close to launch as practical with Operations Safety present.
- Results of the checkout are reported by Operations Safety to the MFCO during the launch countdown.
- At the time specified in the countdown/pre-count, the OSM's must be on station at the Operations Safety Console in the blockhouse/Launch Control Center and at the launch area.
- The OSM is responsible for clearing all non-essential personnel from the Flight Caution Area during caution periods and for proper housing of essential personnel within the Flight Caution Area during danger periods.
- The OSM controls all warning devices provided to indicate caution and danger periods.
- The OSM declares caution and danger periods at the times such action becomes necessary in the interest of safety.
- At a mutually agreed upon point in the countdown, the OSM confirms to the MFCO that the Flight Caution Area is clear.
- The OSM initiates HOLDFIRE when safety constraints or emergency situations dictate.

2.4.5.7.2 Countdown Operations

Three separate documents are published to govern launch activities - Launch Countdown, Phase 1, details the work required, step-by-step, to prepare the vehicle from the start of the countdown at T-25.5 hours, to the final 'pad clear' at about T-4 hours. Launch Countdown, Phase 2, is the worksteps performed from the launch van, or by the range for the final hours of countdown through launch. The Launch Commit Criteria (LCC) is employed throughout the countdown to identify the allowable criteria limitations for weather, launch vehicle, or spacecraft systems. While it is the policy of the LLV program to publish all procedures at least thirty days prior to their first use, the need to ensure that the latest information is incorporated holds the final release of the three launch documents until a week to

10 days prior to launch. All three documents are coordinated with, reviewed by, and approved by spacecraft and launch vehicle engineering, vehicle operations, range operations, and Range Safety.

The personnel most involved in decision making during launch countdown include the following:

Range Personnel:

- Senior Mission Flight Control Officer (SMFCO)
- Mission Flight Control Officer (MFCO)
- Range Operations Commander (ROC)
- Range Control Officer (RCO)
- Launch Weather Officer (LWO)
- Operations Safety Manager (OSM)
- Complex Safety Officer (CSO)

Range User Personnel:

- User Launch Director (LD)
- Assistant Launch Director (ALD)
- Telemetry Systems Observer (TSO)
- Guidance Systems Observer (GSO)

Payload Personnel:

- Payload Operator (PLO)

The responsibilities of each during countdown operations are as follows.

SMFCO - The SMFCO is directly responsible to the 30th SPW Commander for the safe conduct of a launch during countdown and flight operations. He manages the mission flight control team during launch phase operations, maintains an overall view of range safety and vehicle prelaunch status, and directs the MFCO in critical safety decisions including countdown holds and flight termination.

MFCO - The MFCO is the safety focal point during all vehicle flight operations. He is responsible for controlling and coordinating the flight control portion of the countdown, and directs the actions of the mission flight control team. He is also responsible for overall launch hazard assessment by ensuring the range is clear of any traffic (i.e., trains, boats, planes, people) by interfacing with the railroad monitor systems, ship radar, and airplane radar. He determines safety readiness to support the launch, monitors checkout procedures on the flight termination system, and conducts destruct systems tests. With the SMFCO's concurrence, he provides the safety readiness GO/NO-GO decision to the ROC.

ROC - The ROC is the senior range representative for launch operations. He serves as the interface between the launch agency and the range, and manages, directs, and controls range resources to ensure all range instrumentation is capable and ready to support launch operations. He is responsible for range support during the generation and launch phase of operations, including range instrumentation support, contingency support requirements, aircraft/seacraft support, and support by off-range assets. He certifies range readiness and provides the launching agency the final overall range GO/NO-GO recommendation.

RCO - The RCO is responsible for the management of all operational range instrumentation. He directs all range system interfaces with user systems and coordinates with range system controllers to ensure mission-capable support during range operations. He reports status and GO/NO-GO recommendations to the ROC.

OSM - The OSM is responsible for all flight safety hardware on the launch vehicle. This includes the FTS receivers and the C-Band transponder. He is responsible for verifying the operation of the FTS. He resides at a console position in the LLV Launch Van, monitors arming of the FTS, and, with approval of the MFCO, enables or disables continuation of the countdown via the enable switch. He has a CRT screen with FTS specific telemetry to determine that status. He also has access to other telemetry data in order to monitor various other components of the vehicle.

Upon the OSM's receiving of a GO from the MFCO during terminal countdown, it is implied that the OSM and the CSO are also GO. During terminal countdown, all actions involving the OSM and CSO must be approved by the MFCO. The OSM and CSO are not "mission ready" certified positions and therefore cannot be responsible for GO/NO-GO decisions; however, the OSM and CSO may be polled independently.

CSO - The CSO is responsible for site safety at the launch complex and reports site status as appropriate. He has the ability to control site aural/visual warning devices and pad video. He assures that the pad is clear for launch via video monitors, and is assisted by the Complex Safety Technician who participates and monitors the vehicle arming operations. On launch day, the CSO resides at a console position in the Launch Van, and is responsible for all safety aspects of the launch complex, including pad clearing and re-entry.

LWO - The LWO is responsible for providing the latest weather information to the launch team. He is available for weather briefings at any time during countdown.

LD - The LD is the range user's single point-of-command authority overseeing the launch team functions and responsibilities. He has the authority to stop the countdown at any point in the process, and is responsible for issuing final launch authorization. He ensures overall control of the countdown, maintains team discipline, and provides coordinating direction to the launch team during emergencies/contingencies, scrubs/recycles, and post-launch activities. Has final signature approval of all changes to the launch countdown procedure. He resides at the LLV Launch Van console position OPS 1, has authority over all testing activities, and works with Range Safety and the user system safety engineer to ensure safety during launch/test activities.

ALD - The ALD assists the LD in coordinating the activities in the Launch Van during launch countdown. He is capable of performing the functions and responsibilities of the LD should the need arise, and resides in the LLV Launch Van at console position OPS 2.

TSO - The Telemetry Systems Observer resides in the Launch Van.

GSO - Guidance/Navigation Systems Observer resides in the Launch Van at the telemetry ground station.

PLD1 - PLD1 is the payload manager who resides in the Launch Van and monitors the payload telemetry prior to launch to ensure the payload is ready to launch. He must rely on upper management and the Customer for decision to approve readiness of the payload. Once approval is received, a GO/NO-GO decision is relayed to the LD.

PLD2 - PLD2 is the assistant payload manager who resides in the Launch Van.

During terminal countdown, there are really only two decision-makers, the MFCO and the LD. The Launch Van contains the essential personnel to support the LD in his decision-making process from the vehicle point of view (including the payload) and does not have to rely on any other management direction. The MFCO, with the support of the SEM representative and CSO, will enable the flight termination system and give the GO/NO-GO decision to the LD, based on the range criteria being met for a safe launch. It is then the responsibility of the LD to initiate launch.

After T-0, however, the responsibility shifts solely to the MFCO who is tracking the vehicle to determine the vehicle flight path with respect to range limit lines, which are predetermined and specific to the vehicle's accelerations. He has the sole responsibility to terminate flight if flight safety criteria are violated.

To ensure constant communication between the MFCO and the LD, the following means of contact are normally in place:

- Voice Direct Lines (VDL's), a primary and backup;
- Countdown Net (C/D), a primary and backup;
- Status and Alert Lights installed at the consoles to indicate the GO/NO GO decisions that have been made.

After launch, the range user plays no role in the flight other than having the ability to observe telemetry data. Non-Safety personnel are not linked to the safety net in order to eliminate any potential distractions that may occur during dialogue between safety personnel as they monitor the vehicle. NOTE: The ability to monitor the safety net by other than Range Safety personnel is being negotiated.

For pad launches, a T-X time is identified, if applicable, as that time in the countdown after which an attempt to hold the launch would be more hazardous than allowing it to proceed. This time is tentatively identified by the range user and coordinated for concurrence with Range Safety. No hold is initiated after T-X for any flight control or Range Safety item. There is no T-X time for Atlas or Delta (Atlas and Delta can hold down to the point of ignition).

2.4.5.7.3 Inflight Operations

After vehicle ignition, the MFCO receives an "ignition" and "lift-off" call from the Vertical Wire Skyscreen Officer followed by a status report from the Telemetry Systems Officer. The Vertical Plane indicator is the first display item to generate history and appear to move, followed by the Instantaneous Impact Predictor. All MFCOs report on a common voice net with a continuing dialogue as flight proceeds downrange and display maps change automatically. The Wire Skyscreen operator will report any abnormalities and staging events, if observed. The TM will report vehicle performance and events as displayed on the Range Safety Telemetry Display System. Any malfunctions or trajectory divergences observed by one MFCO will be confirmed by another MFCO.

The Command Systems Officer monitors command carrier switching for the flight termination system as the vehicle proceeds downrange and below the horizon to the CCAS command site. The CMEV's in the CCRS use plus time and elevation data for each command station to determine automatically which station should be radiating the command carrier.

2.4.6 Personnel Training and Certification

This section addresses the training and certification of mission essential personnel: those personnel who are critical to the Range Safety function.

2.4.6.1 MFCO Training

The Mission Flight Control Officer is a member of the Flight Control and Analysis Section of the 45 SW Safety Office. However, during launch operations, the MFCO is the official representative of the Wing Commander and is responsible for taking all reasonable precautions to minimize the risk to life and property during a launch vehicle's flight.

Initially, each potential MFCO undergoes supervised training and checkout in assigned launch vehicle flight control launch support positions. These positions include Vertical Wire Skyscreen, Telemetry, Command MFCO, Forward Observer, and Surveillance Control Officer. The trainee observes, participates, and is formally checked out in each position during actual launches. In addition, he is trained as a primary MFCO in simulated launch exercises where failures in instrumentation and communications are simulated. These exercises are not only designed to familiarize the trainee with potential problems and solutions, but are also used to gauge his judgment, reaction time, and stability under stress.

The trainee becomes familiar with the range, its instrumentation, facilities, and personnel through conducted tours and briefings. He is assigned a launch vehicle program and becomes familiar with all aspects of its functions, systems, and operational characteristics. The trainee is also assigned an alternate launch vehicle program and replaces the primary MFCO for that program when necessary.

The trainee is checked out as a primary MFCO only after satisfactorily completing all initial phases of the training program. Final checkout consists of manning the MFCO console during an actual launch vehicle launch as the Wing Commander's official representative, responsible for terminating a launch vehicle flight if established safety criteria are violated. The MFCO continues to increase in experience and knowledge by assisting other primary MFCOs during their launches and training exercises, and by undergoing recurring MFCO training as necessary.

After the MFCO trainee has successfully completed training, he and the Training Officer meet with the Section Chief to review and evaluate the trainee and his records. The Section Chief will, after conducting this review, recommend to the Wing Commander that the trainee be certified as an MFCO, or advise the Training Officer that additional training is required.

2.4.6.2 Launch Vehicle Flight Analysis Training

No formal training plan currently exists for new flight analysts coming into the Flight Control and Analysis Section. All personnel are degreed mathematicians or scientific analysts. On-the-job training is the primary method used for flight analysis personnel. The trainee is assigned a specific vehicle program and receives guidance and instructions from a senior analyst who reviews and approves the trainee's work. The trainee performs analyses of vehicle performance, failure modes, spent stage impact debris, impact limit lines, destruct lines, and many other safety related issues. These analyses help to assure that the proposed space vehicle missions are being conducted in a manner consistent with flight safety criteria.

2.4.6.3 Launch Vehicle System Safety Training

All personnel in the Systems Safety Section are subject to training requirements dictated by their position descriptions. Training is accomplished in a variety of different ways, ranging from individual self-study courses and technical seminars and symposiums, to diverse college-level courses presented by many universities and colleges across the country. Section resources play a significant role in the overall training program.

A formal training plan has been established and has been in force within the System Safety Section for many years. The initial training phase covers approximately 52 weeks for a safety engineer entering at the GS-07 level. Training is provided by designated subject matter specialists (within or outside of the System Safety Section) or at government training facilities. The trainee is required to attend and satisfactorily complete formal academic programs at the undergraduate and/or graduate level. On-the-job training is a very important part of the training process. Areas that the trainee is exposed to include the following: pad safety, facilities, governing safety directives, explosives safety, flight termination systems, nuclear safety, solid/liquid propellants, toxic hazards, hypergolics, launch vehicles, downrange stations, industrial safety, ground safety, and payload safety.

2.4.6.4 Other Training

In addition to the above training requirements, there are a number of other critical areas that also must meet stringent training criteria. For example, the Operations Safety Manager must undergo a rigid training program. He is the MFCO's on-scene representative, verifying that all aspects of the destruct system tasks have been done in accordance with approved procedures. Similar training/certification requirements exist for instrumentation operators, radar personnel, the command destruct transmitter technicians, and a number of others.

2.4.7 Eastern Range Interfaces

Interfaces between Range Safety and other internal ER organizations are as follows:

2.4.7.1 Commander, 45th Operations Group (45 OPG)

The 45 OPG Commander is responsible for:

- Complying with, implementing, and enforcing the Range Safety Program.
- Reviewing and accepting all prelaunch and launch operations procedures at CCAS for Air Force Programs, including hazardous and safety critical procedures that

may affect public safety or launch area safety, after insuring they have been approved by Range Safety.

- As a control authority, in accordance with the Range Safety Training and Certification Plan, reviewing, approving, and accepting prelaunch and launch operations procedures for Air Force programs that are limited to launch complex safety concerns.
- Providing Range Safety with the instrumentation, computers, communications, command transmitter systems, and Range Safety display systems necessary to carry out prelaunch and flight safety functions. Range Safety provides the 45 OPG with mandatory and required support, and the 45 OPG ensures that these requirements are met.

2.4.7.2 Commander, 45th Logistics Group (45 LG)

The 45 LG Commander ensures that all required instrumentation, computers, communications, command systems, and Range Safety display systems necessary for Range Safety to carry out its functions meet Range Safety requirements, perform to the prescribed level of reliability, and are designed in accordance with Range Safety specifications and requirements.

2.4.7.3 Commander, 45th Medical Group (45 MED GP)

The 45 MED GP Commander is responsible for determining, coordinating, and enforcing medical, biological, and radiological health requirements. The Radiation Protection Officer and Bioenvironmental Engineering are responsible for establishing and implementing their programs in coordination with the Safety Office (45 SW/SE).

2.4.7.4 Other

The appropriate ER agencies provide computational, plotting, and reproduction services for flight control planning and preflight requirements as follows.

- Operate computing and plotting equipment at the Central Computer Complex and Technical Laboratory Computer Facility.
- Perform analytical studies, formulate mathematical models, and develop computer programs to meet specifications established by SEO.
- Maintain, document, and operate the computer programs listed in the current Semiannual Computer Program Survey document.
- Process magnetic tapes and provide computer listings and trajectory output files.
- Compute random and systematic errors for the instrumentation systems used for flight control. Errors must be converted to appropriate statistical parameters to evaluate the magnitude of real-time impact predictor errors throughout thrusting flight.
- Calculate acquisition times, look angles, aspect angle, and signal strengths to arrive at tracking, telemetry, and command destruct expected coverage estimates.

- Maintain the real-time impact prediction program and other related real-time and prelaunch programs. Evaluate time delays in the real-time program and in associated instrumentation systems.
- Provide miscellaneous reproduction and photographic services and prepare viewgraphs and briefing slides as required.

2.4.8 Range User Responsibilities and Requirements

The range users have the responsibility to provide safe systems, equipment, and facilities and to conduct their operations in a safe manner that complies with and implements those portions of the ER safety program that are applicable to their program. This is accomplished by joint Range Safety/range user review and approval of components, systems, and subsystems at design reviews; the approval of hazardous operations and their associated operational procedures; the acceptance and qualification tests for critical systems, such as the FTS; the review and approval of quantity-distance siting for all support facilities and launch complexes; and the data required for flight plan approval.

2.4.9 Computer Programs

Computer programs used by Range Safety and support organizations are listed in the Appendix with a brief discussion on each.

BIBLIOGRAPHY

1. 45th Space Wing, Eastern Range Instrumentation Handbook, Sept 1994
2. Eastern & Western Range Safety Policies and Processes 127-1, 31 Oct 1997
3. Internet, www.pafb.af.mil
4. Eastern Range Customer Handbook
5. Written comments from 45th SW/SE and 45th SW/CES (DRAFT Report, Nov 1996)
6. Basic Information Guide for Cape Canaveral, 01 Oct 1994
7. Technical discussions with Range Personnel
8. Personal knowledge and experience of RTI staff members
9. Flight Analysis General Reference Handbook, 24 April 1997
10. AFSPC 80-12, Standard Theoretical Trajectory Magnetic Tape Format, (DRAFT)
11. 45th Space Wing Instruction 99-101, Mission Program Documents, 07 October 1994
12. RTI collected site visit information and ER submitted data
13. AFI 32-7061 “Guidance on Commercial Space Activity”
14. AFI 32-9003 “Granting Temporary Use of real Property”
15. AFMAN 91-201 “Explosive Safety Standards”
16. DoD 6055.9-STD “DoD Ammunition and Explosive Safety Standard”
17. DoDD 3200.11 “Major Range and Test Base Facility”
18. DoDD 3230.3 “DoD Support for Commercial Space Activities”
19. FAA/AST 14 CFR, Chapter III, “Commercial Space Transportation: Licensing Process for Commercial Space launch Activities”
20. Public Law 60, 81st Congress, 1st session, “Guided Missiles Joint Long Range Proving Ground”
21. Public Law 91-190 “National Environmental Policy Act”
22. Public law 98-575, 49 USC 2601-2623 “The Commercial Space Launch Act”

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APPENDIX A

The following list of computer programs are used by the 45th SW Range Safety and supporting organizations:

PROGRAM	Computer /User	USAGE	Description
COLA Collision Avoidance Program	Cyber/SEY & RTS (CCAS) Contr.	Pre Operation	Computes closest approach of launch vehicle and orbiting object.
DFPC Debris Footprint Processor Console	DEC 212LP PC/RTS (CCAS) Contr.	Realtime	Displays DFPH-generated graphics data acting as the operator's console.
DFPH Debris Footprint Processor Host	VAX 3900/RTS (CCAS) Contr.	Realtime	Generates graphics footprint Displays in accordance with Information received from DFPC and DFPI.
DFPI Debris Footprint Integrator	12 DECstation 3100s/RTS (CCAS) Contr.	Realtime	The DFPI system consists of 12 DECstation 3100s with one processor acting for each of ten possible pieces to be processed. An eleventh processor acts as the hull generator and a twelfth Processor is available as a hot spare.
DRSD Distributive Range Safety Displays	FEP 80486 and Display DECstation 5000/RTS (CCAS) Contr.	Realtime Backup Launch Support	Backup realtime system used to monitor the flight of vehicles launched from CCAS.
FPTP Footprint Pre-Test Program	Cyber/RTS (CCAS) Contr.	Pre-Operation	Collects debris piece parameters, atmosphere and wind data, and key piece specific data and prepares a file for the realtime footprint program.
FUDZ Footprint Users Display on the Zenith PC	Zenith 150 PC/RTS (CCAS) Contr.	Realtime	Controls footprint display Output from cyber program RCCF.

PROGRAM	Computer /User	USAGE	Description
GDIGTP5 Geodetic Translation	Cyber/SEY	Analysis	Performs various coordinate system conversions, (Procedure is +,IGTP)
LARA Version 20 Launch Risk Analysis	Cyber/SEY	Analysis	Launch area mission risk Analysis and related Programs.
PREX Preparation of VAX Backgrounds	Cyber/RTS (CCAS) Contr.	Pre-Operation	Assembles information Specified in the Range Safety requirements letter and generates a file that is used to produce the Range Safety display background.
PROX Preparation of VAX Background Verification	Cyber/RTS (CCAS) Contr.	Pre-Operation	Assemblies' information specified in the Range Safety verification letter and generates an output to use at the VAZ computer.
RAID Realtime Acquisition and Impact Display	Cyber/RTS (CCAS) Contr.	Realtime single vehicle support	Used at CCAS to support all single launch vehicles. Sends information to the Range Safety displays.
RCCF Realtime Continuous and Catastrophic Footprint	Cyber/RTS (CCAS) Contr.	Realtime Footprint	Operates under the RAID program to provide realtime footprint support.
RFFT3 Range Safety Free Flight Trajectory & Impact Point	Cyber/SEY	Analysis	Generates a free flight trajectory. (Procedure is +,RFFT)
RIPP3 Range Safety Impact Point & Destruct Line plot	Cyber/SEY	Analysis	Produces Calcomp plots of maps, trajectories, destruct lines, critical events, etc. (Procedure is +,RIPP)

PROGRAM	Computer /User	USAGE	Description
RLAN5 Range Safety Look Angle Program	Cyber/SEY	Analysis	Computes azimuth, elevation And range (look angles) from a ground location to a trajectory. (Procedure is +,RLAN)
RSAC2 Range Safety Angle Combining	Cyber/RTS (CCAS) Contr.	Pre-Operation	Produces an output that contains the most critical destruct criteria grid from up to 3 RSCA cases.
RSAT Range Safety Atmosphere Model Program	Cyber/RTS (CCAS) Contr.	Atmos.	Generates a series of overlapping continuous cubic polynomial fits to represent large quantities of data points. Provides optional plotting on the Calcomp plotter.
RSCA6 Range Safety Critical Angles	Cyber/RTS (CCAS) Contr.	Pre-Operation	Generates a two-dimensional field of critical angles for various vehicle pieces with respect to time.
RSCD5 Range Safety Chevron Destruct Lines	Cyber/RTS (TLCS) Contr.	Pre-Operation	Produces Calcomp plots and files of close-in impact predictor (Chevron) destruct lines.
RSCP6 Range Safety Critical Planes	Cyber/RTS (CCAS) Contr.	Pre-Operation	Produces vertical plane plots on the Calcomp plotter.
RSDL5 Range Safety Destruct Line Program	Cyber/RTS (CCAS) Contr.	Pre-Operation	Calculates the impact Predictor destruct criteria. Also, is used in generating footprint background information.
RSDP5 Range Safety Destruct Line Plotter	Cyber/RTS (CCAS) Contr.	Pre-Operation	Uses RSDL output file to generate impact templates in envelope form.

PROGRAM	Computer /User	USAGE	Description
RSEE9 Range Safety Error Ellipse	Cyber/RTS (CCAS) Contr.	Analysis	Computes impact error ellipses from single stations or trilateral stations tracking input.
RSGC1 Range Safety Gravity Corrected Reduced Velocities	Cyber/SEY	Analysis	Computes no-turn failure Mode position data. Removes gravity term from range user trajectories. (Procedure is +,RSGC)
RSGNO Range Safety Green Number	Cyber/SEY	Pre-Operation	Computes green numbers for Range Safety displays. (Procedure is +,RSGNO)
RSIP6 Range Safety Impact Predictor	Cyber/SEY & RTS (CCAS & TLCS) Contr.	Analysis	Computes predicted impact positions of vehicles or Pieces.
RSIT RSTS Interpolation	Cyber/SEY	Analysis	Interpolation for output from RSTS.
RSKP4 Range Safety Dispersion Envelope	Cyber/RTS (CCAS) Contr.	Analysis	Computes impact points of a launch vehicle if all control were lost at specified time to yield an estimate of the dispersion envelope.
RSKR1 Range Safety Chart Boundaries	Cyber/SEY	Analysis	Computes the Range Safety display boundaries in latitude and longitude. (Procedure is +,RSKR or +,PROCKR)
RSMR7 Range Safety Maximum Range	Cyber/RTS (CCAS) Contr.	Analysis	Computes maximum pad-to-impact range for a launch vehicle given an initial slant range and scalar velocity.
RSPC5 Range Safety Probability Contour	Cyber/RTS (CCAS) Contr.	Analysis	Calculates the rectangular or geodetic coordinates defining a specified contour, and generates a Calcomp file, regarding probability that impact pieces will hit an object-of-concern.

PROGRAM	Computer /User	USAGE	Description
RSPF1 Range Safety Powered Flight & Turns	Cyber/RTS (CCAS) Contr.	Analysis	Produces a family of Malfunctioning trajectories. Output files are used for Programs RSTS and RSIP.
RSRB5 Range Safety Range & Bearing Program	Cyber/SEY	Analysis	Computes range and bearing Between two points, direct Solution, or geodesic. (Procedure is +,RSRB)
RSSP2 Range Safety Ship Hit Probability Program	Cyber/RTS (TLCS) Contr.	Pre-Operation	Computes the probability of a Boat or ship located in the Launch area being hit by Vehicle debris. Also Generates a Calcomp plot.
RSTC3 Range Safety Trajectory Critical Angles	Cyber/SEY & RTS (CCAS) Contr.	Analysis	Using RSCA or RSAC input Files, produces critical angles From a Range Safety Trajectory file. (Procedure is +,RSTC)
RSTS6 Range Safety Template Sorting	Cyber/RTS (CCAS) Contr.	Pre-Operation	Sorts, merges and generates Calcomp plots of chevron Destruct line data from files Produced by RSPF and RSIP.
RSTT3 Range Safety Tumble Trajectory	Cyber/SEY	Pre-Operation	Produces a tumble trajectory.
RSTX1 Range Safety Training Exercise	Cyber/SEY	Range Safety Training	Computes deviant present Position trajectories (left or right turns, pitch-up or pitch-down, or combinations of turn and pitch) from a Nominal trajectory to use for OD-16 exercises. (Procedure is +,OD16)
RSVF4 Range Safety Verify Program	Cyber/SEY	Verify Range Safety displays	Produces card image file for Input to the PROX or TROX Program. (Procedure is +,RSVF)

PROGRAM	Computer /User	USAGE	Description
RSV12 Range Safety Variable Interpolation	Cyber/SEY	Analysis	Performs linear and non-Linear interpolation. (Procedure is +,RSVI)
RSWC3 Range Safety Wind Check	Cyber/RTS (CCAS) Contr.	Pre-Operation	Computes the amount by Which the impact point drifts From the impact limit line Given a wind profile.
RSZC Range Safety Requirements Letter	Cyber/SEY	Pre-Operation	Generates standardized letter for the CCC. (Procedure is +,RSZC)
RTAR4 Range Safety Translation & Rotation	Cyber/SEY	Analysis	Translates, rotates and scales Position and velocity data From one fixed location on the earth's surface to another. (Procedure is +,RTAR)
RTRC4 Range Safety Translation & Rotation Scale Calculation	Cyber/SEY	Analysis	Computes the translation and Rotation scale calculations for Any given trajectory. (Procedure is +,RTRC)
RTRP4 Range Safety Translation & Rotation Plotting	Cyber/SEY	Analysis	Generates plots of a pad-referenced trajectory in a site-referenced system. (Procedure is +,RTRP)
RVIP3 Range Safety Vacuum Impact Prediction	Cyber/SEY	Analysis	Calculates vacuum impact Prediction points (latitude And longitude) for a Trajectory. (Procedure is +,RVIP)
RVPT4 Range Safety Vertical Plane Plot	Cyber/SEY	Analysis	Creates plot of vertical plane Trajectories. (Procedure is +,RVPT)

PROGRAM	Computer /User	USAGE	Description
TAIL Trident Acquisition & Impact Location	Cyber/RTS (CCAS) Contr.	Realtime Multi-Vehicle Launch Support	Supports up to four near-Simultaneous Trident Launches in realtime. Data is Sent to the Range Safety Displays.
THEO Theoretical Tape Generator	Cyber/RTS (CCAS) Contr.	Pre-Operation	Simulates realtime raw data as it would originate from any instrumentation site selected.
TROX Multi-Vehicle Background Verification	Cyber/RTS (CCAS) Contr.	Verify Range Safety displays	Assembles information Specified in the Range Safety Verification letter and Generates a file that is used to Verify the Range Safety Multi-Vehicle display background Information.
TTUD Titan Trajectory Update Delta	Cyber/RTS (CCAS) Contr.	Realtime Launch Support	Copies a file containing time and delta position values during the countdown. Subsequently uses the file to update nominal Range Safety displays of VP and IP for launch day winds.
VODS VAX Multi-Vehicle Display System	VAX/RTS (CCAS) Contr.	Realtime Launch Support	Places information received From the TAIL program on the Range Safety displays.
VXDS VAX Display System	VAX/RTS (CCAS) Contr.	Realtime Launch Support	Places information received From the RAID program on the Range Safety displays.
VVDS VAX Verification	VAX/RTS (CCAS) Contr.	Verify Range Safety displays	Loads display files created by VXPT and activates them via Keyset selected.
VXPT VAX Pre-Test Program	VAX/RTS (CCAS) Contr.	Pre-Operation	Generates the Range Safety Display backgrounds from the Input generated by the PREX Program.